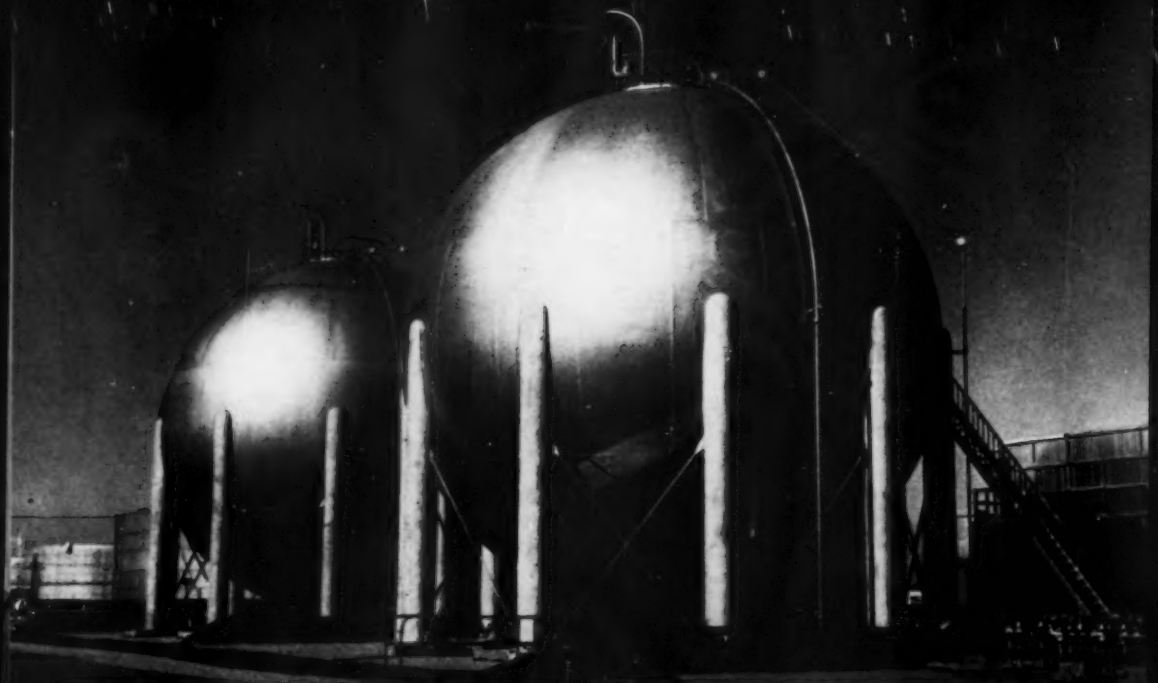
FEBRUARY, 1952

PETROLEUM REFINER

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

Throughout the petroleum industry, HORTONSPHERES prove the most efficient method of storing butane, butane-propane mixtures and volatile refinery stocks. That's because they are especially designed to resist internal pressures resulting from high volatility or pressure variations caused by temperature change. Contents will not escape if the internal pressure does not exceed the setting of the relief valve.

HORTONSPHERES are built in standard capacities of 1,000-bbls. for 30 to 200 lbs. per sq. in. pressure; 1,500 to 2,500-bbls. for 30 to 150 lbs. per sq. in. pressure; 5,000 to 7,500-bbls. for 30 to 100 lbs. per sq. in. pressure; 10,000 to 15,000-bbls. for 30 to 75 lbs. per sq. in. pressure; 20,000-bbls. for 30 to 60 lbs. per sq. in. pressure; and 25,000-bbls. for 30 to 50 lbs. per sq. in. pressure.



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puts the HEAT on heat exchangers

By changing to Yarway Impulse Steam Traps, an oil refinery reports much hotter steam in their heat exchangers **—plus two other important extras:**

(1) They were able to operate the plant with 6 boilers instead of the 8 formerly required.

(2) Three men formerly required to service old-type traps can now be used for productive work.

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Plant after plant is standardizing on Yarway Impulse Steam Traps because Yarways are designed to deliver the most premium B.T.U.'s at top temperatures into your process or product. **They get equipment hotter, sooner ... and keep it hot.**

Other reasons—small size, easy installation, good for all pressures, only one moving part, low maintenance, low price.

Buy your Yarway Impulse Steam Traps from the nearest of 216 distributors. For name, write us.

ACTUAL SIZE ¾" YARWAY STEAM TRAP

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FREE OFFER. Don't take our word for it. Test Yarway's advantages in your own plant, without cost or obligation. Drop us a card or letter—a trial trap will be delivered promptly.

YARWAY the steam trap

designed with more production in mind

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No. 2

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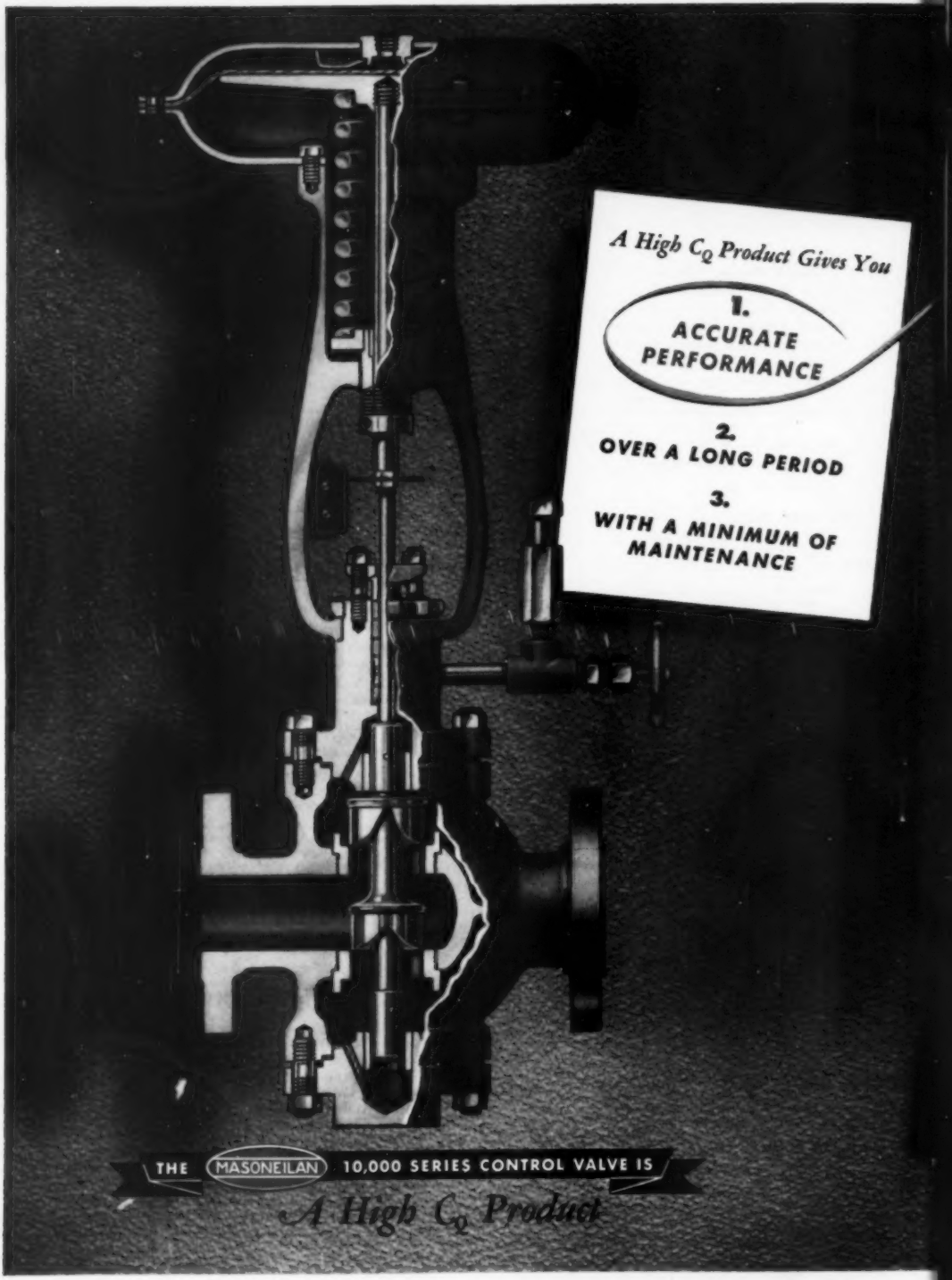
A High C_Q Product Gives You
1.
ACCURATE PERFORMANCE
2.
OVER A LONG PERIOD
3.
WITH A MINIMUM OF MAINTENANCE
THE MASONEILAN 10,000 SERIES CONTROL VALVE IS
A High C_Q Product

In Control Valve Performance the No. 1 Quality Factor is

Accuracy

A number of other quality factors enter into the design and manufacture of a control valve which provides "accurate performance, over a long period, with a minimum of maintenance". Such interrelated factors as rugged mechanical construction; selection of materials, types, sizes, and associated equipment; convenience in servicing, etc. are important. But without accurate performance these are meaningless.

Here is how Masoneilan Control Valves are designed and built to assure this accurate performance:

Correct Flow Characteristics

Plug contours designed and flow tested to provide accurate flow characteristics over widest practical range. A variety of precision machined plugs permits selection of most suitable construction as well as the desired flow characteristics for the service conditions.

Wide Flow Range

Low minimum flow (because of smallest practical clearance between plug and seat ring obtainable by precision machining), large diameter seat rings and long stroke combine to insure wide usable flow range.

Large Body Flow Areas

provide required C_v with minimum pressure drop due to body restrictions.

Responsive, Positive Diaphragm Motor

with large diaphragms, pre-formed to provide sensitivity and power, to maintain effective area throughout valve stroke and to minimize hysteresis. Calibrated springs for 3-15 or 6-30 psi range. Stop in upper diaphragm case establishes correct initial diaphragm position, avoiding faulty adjustment.

Accurate Alignment

from diaphragm to blindhead, insured by pre-formed diaphragm; by precision control of clearance in stuffing box parts, guide bushings and plug guide section; by piloting of seat rings in body bridge wall; by piloting one-piece bonnet and blindhead in body; by rigid fastening of diaphragm motor to body by heavy forged steel drive nut.

Minimum Friction

insured by accurate alignment; by finish of honed and highly polished valve stems; by finish of extra deep stuffing box parts; by self-aligning frictionless guide provided by diaphragm; by oilite bronze lower guide.

In selecting control valves consider first the "Accuracy of Performance" quality factor — but evaluate the other quality factors too — the factors that insure accuracy "for a long period, with a minimum of maintenance". For the sum of *all* quality factors is the C_Q (Quality Coefficient) and in comparing cost remember that the *real* cost includes invoice price plus cost of maintenance and down-time. Thus for comparison, among comparably priced valves the best buy is the one with the highest Quality Coefficient —

$$\text{for Real Cost} = \frac{\text{Price}}{C_Q}$$

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This month's report is on: **DM STEEL**

Has unusually high creep strength for a pearlitic steel, good stability up to 1200°F., fairly good corrosion and oxidation resistance. Has 2 to 3 times the life of carbon steel where corrosion is not severe. Recommended for cracking furnace tubes, hot oil lines, superheater tubes, high temperature steam piping and forgings for accessory parts.

23 TIMKEN® STEELS FOR HIGH TEMPERATURE SERVICE

Carbon	Sicromo 2	Sicromo 5S	16-13-3
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-12
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

*Not available as seamless tubing at the present time.

Pictured above is a direct-reading spectrometer, used in the Timken Company's Spectrographic Laboratory. It chemically analyzes a molten heat of Timken steel in just 40 seconds, makes possible precise control of the steel's properties.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

WORMS EYE VIEW OF SAFE STORAGE

View shows bottom of recently erected 200,000 gallon Posey Iron Elevated Tank.

POSEY IRON STANDS READY TO *DESIGN* . . . *FABRICATE* . . . and *ERECT* elevated tanks in all capacities up to maximum. Posey Iron's experience in steel plate construction (dating back to 1910) eliminates needless production fumbling . . . cuts costs and speeds delivery.

All standard codes are met with adequate safety margins. Quality materials only are selected. Many Posey Iron installations are made with equipment performance guaranteed. Write today for free, illustrated 12-page reference bulletin.

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DIVISIONS: BRICK MACHINERY • INDUSTRIAL HEATING • IROQUOIS • SHIPBUILDING • STEEL PLATE

FACT

An average-size refinery can save $50,000 in first cost by using Alcoa Aluminum Heat Exchanger Tubes!

(Figured on 20,000 Tubes)

This is based on current tube prices . . . ½ less than seamless mild steel, ½ as much as Admiralty, ⅙ the cost of stainless. Compare these savings in aluminum against the metal you now use.

ALCOA

knows most about their use and application

Alcoa pioneered the use of aluminum in heat exchanger tubes 43 years ago. Although their sale today is limited by government regulation, you will want to start planning with a copy of the booklet, "Alcoa Aluminum Heat Exchanger Tubes". Write:

ALUMINUM COMPANY OF AMERICA
1866B Gulf Building • Pittsburgh 19, Pa.

OVER 6-MILLION FEET OF ALCOA TUBES ARE IN USE FOR APPLICATIONS LIKE THESE . . .

PETROLEUM

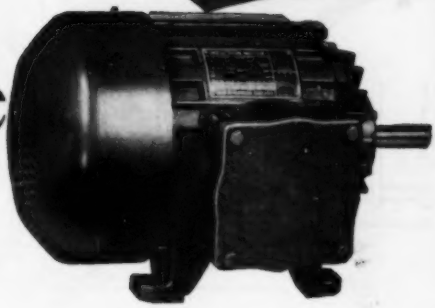
Condensers handling hydrocarbon fractions from such processes as Thermal and Catalytic cracking, reforming, polymerizing, etc.
Vapor recovery condensers
Lube oil coolers
Natural gas compressor aftercoolers
Recompressor aftercoolers
Hydrogen sulfide gas coolers
Furfural condensers and heat exchangers
Propane chilling
Wax sweaters
Lean oil—rich oil exchangers
Amine solution coolers
Glycol-amine solution coolers, heat exchangers and reboilers

CHEMICAL

Butanol
Ethanol
Ethylene Glycol
Glycerin
Hydroabietyl
Isopropanol
Methanol
Phenol
Propylene Glycol
Acetaldehyde
Formaldehyde
Furfural
Heptaldehyde
Acetic acid
Stearic, Palmitic, Maleic Oleic acids
Butyric acid
Naphtha
Ricinoleic acid
Acetanilide
Ammonia
Hydrogen Cyanide
Nitric acid (concentrated)
Pyridine
Hydrogen Sulfide
Benzene
Dichlorobenzene
Gasoline
Gelatin
Hydrogen Peroxide
Turpentine
Xylene

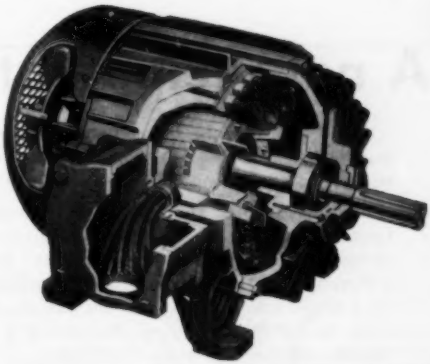
Use Alcoa Alclad 3S-H14 Heat Exchanger Tubes with fresh, brackish and salt-cooling waters

Look Outside



Greatly increased radiating area means greater cooling efficiency. More important, cooling efficiency stays high. There are no enclosed external air passages to clog and cause overheating. If oily dirt sticks, just wipe or blow it off. No matter how bad operating conditions are, this motor can easily be kept clean and cool-running. Electrical parts are protected against corrosive atmospheres by cast iron yokes and end housings.

Look Inside



Double-shielded, heavy-duty ball bearings require no maintenance in ordinary service under most conditions. However, they can be lubricated without disassembly if required. Double shielding prevents over-lubrication, leading cause of bearing trouble. Rotating seals, where shaft extends through housings, keep dirt and moisture out of bearing chambers. Deep rabbet fits between frame and end shield; heavy ribbing and long flame seals on shaft more than meet Underwriters' label requirements for Class I, Group D and Class II, Groups F and G locations.

See WHY THIS IS YOUR BEST MOTOR BUY

HERE IS AN EXPLOSION-PROOF MOTOR that is different from conventional explosion-proof motors; built with an entirely different cooling system that gives you big savings in lower maintenance costs, more continuous service and less trouble in toughest locations. Clogging can easily be prevented in the Allis-Chalmers Type APZZ explosion-proof motor since areas that might collect dirt are exposed and easy to clean. And, of course, it's ideal for outdoor installations.

GET DETAILS NOW — *Ask your nearby Allis-Chalmers Authorized Distributor or District Office for more complete information on this high performance explosion-proof motor. Or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7286.*

A-3879

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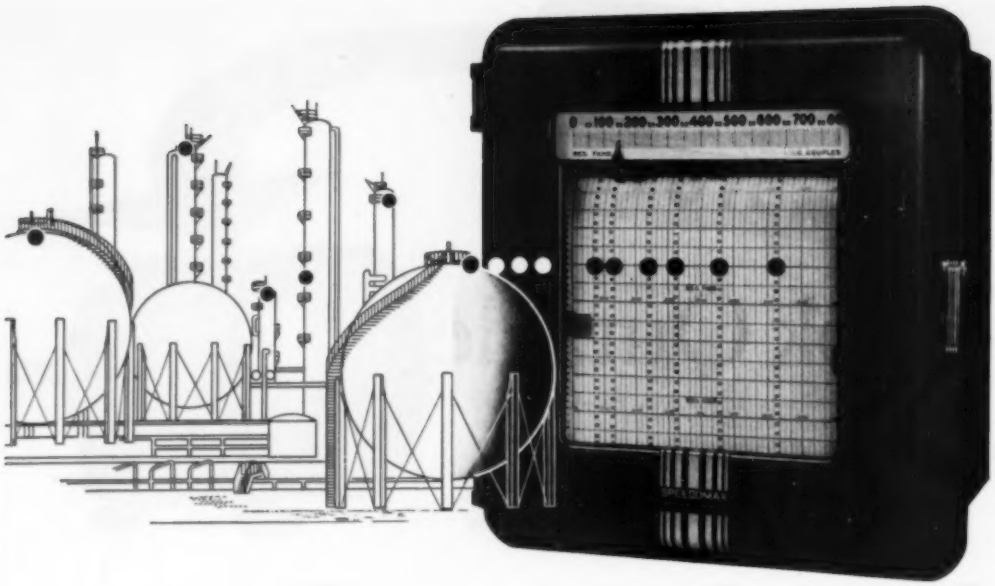


A new temperature Fact every 2 sec!

Today, when many refinery operations may need temperature facts within seconds instead of minutes, the Speedomax story is worth knowing:

For a Speedomax Multiple-point instrument's record-printing "wheel" darts from temperature to temperature in just 2 seconds per point! Thus, if there are, say, 15 fairly important temperatures on a single refinery unit, each one can actually come up and be recorded as often as twice per minute, automatically and continuously.

Two extra checks for vital temps

But suppose a few points require even closer watching, or more frequent recording? Speedomax handles them, too, in either of two ways:

First, they can be recorded more frequently than the other points, in such a sequence as 1, 2, 1, 3, 1, 4, etc.

Second, the vital points can be recorded in greater detail than the other points. This is done by giving the instrument an additional range which is used only with the pre-selected points. This range puts far fewer degrees-per-inch across the instrument's scale; it thus "spreads" the reading for detail.

Ability to measure temperature from any source and across either wide ranges or the new narrow ranges is another L&N specialty. Selection among thermocouples, Thermohms and Rayotubes will determine the correct sensing element. Selection among various recorder components will put the information on paper in the desired form.

160 temps on one instrument

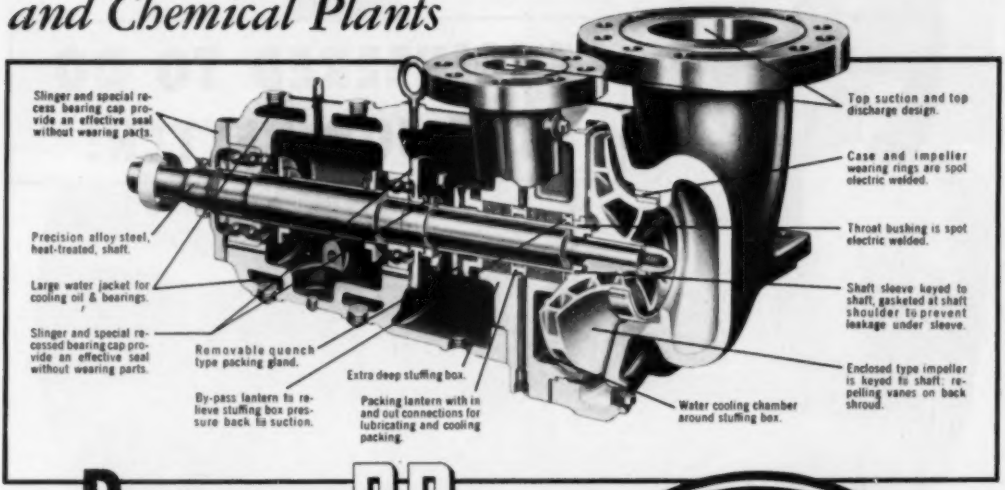
For these and many more features . . . for instance, 160-point models . . . credit Speedomax's refined, stable, dependable construction, both electrical and mechanical. Too, Speedomax is not affected by vibration; never needs levelling up; can measure many quantities besides temperature.

Any L&N office, including 4923 Stenton Ave., Phila. 44, Pa., will send the Speedomax story on request.

LEEDS NORTHRUP

Jrl.Ad. ND46-700(2)

The **PEERLESS IDEA** *of the Modern Heavy Duty Process Pump for Refineries and Chemical Plants*

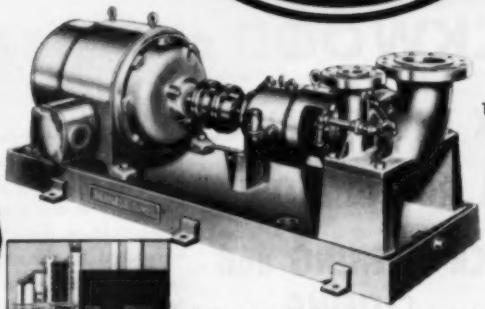

Slinger and special recess bearing cap provide an effective seal without wearing parts.
Precision alloy steel, heat-treated, shaft.
Large water jacket for cooling oil & bearings.
Slinger and special recessed bearing cap provide an effective seal without wearing parts.
Removable quench type packing gland.
By-pass lantern to relieve stuffing box pressure back to suction.
Extra deep stuffing box.
Packing lantern with in and out connections for lubricating and cooling packing.
Water cooling chamber around stuffing box.
Enclosed type impeller is keyed to shaft; repelling vanes on back shroud.
Shaft sleeve keyed to shaft, gasketed at shaft shoulder to prevent leakage under sleeve.
Throat bushing is spot electric welded.
Case and impeller wearing rings are spot electric welded.
Top suction and top discharge design.

Peerless Type PR

ESPECIALLY DESIGNED FOR PUMPING HYDROCARBONS, WATER AND CHEMICAL SOLUTIONS AT ELEVATED TEMPERATURES AND PRESSURES

PEERLESS PUMPS

The sectional view above shows many of the important Type PR pump design and construction features. Other Type PR advantages include maximum parts interchangeability, rugged center-line-mount, extra-low NPSH requirements, optional use of mechanical shaft seal instead of stuffing box, availability in various alloy materials and a complete range of sizes. Some sizes can be furnished from stock in standard materials.



Exterior view Type PR pump. Also available in end-suction top-discharge design.

WRITE FOR NEW BULLETIN giving complete construction details, operating characteristics and application data. Mail coupon at right today.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

Address inquiries to Factories at:
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Offices: New York, Chicago, St. Louis, Atlanta; Dallas, Plainview and Lubbock, Texas; Fresno, Los Angeles, Phoenix; Albuquerque, N. M.; Tulsa

PEERLESS BUILDS *Dependable* **PUMPS**

PEERLESS PUMP DIVISION
Food Machinery and Chemical Corporation
301 West Avenue 26
Los Angeles 31, California

Please send us copy of Peerless Type PR Pump Bulletin No. 8-1605.

NAME _____

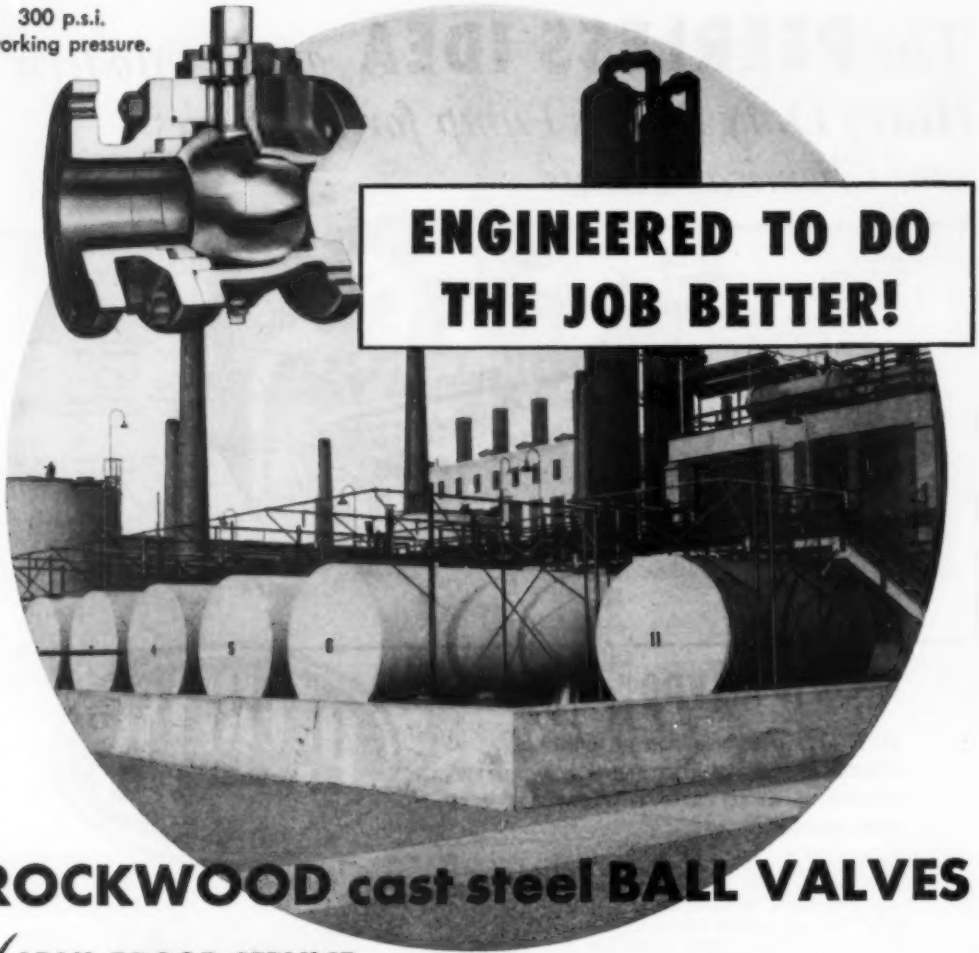
COMPANY _____

STREET _____

CITY _____ STATE _____

PR

300 p.s.i.
working pressure.



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✓ FULL ROUND FLOW

✓ QUICK OPENING and CLOSING

✓ NO MAINTENANCE

These remarkable Rockwood Cast-Steel Ball Valves are engineered to withstand rugged service in refineries, chemical, food, paper, textile and other processing plants. They are more dependable and will operate perfectly over and over again with no maintenance. Full *round* flow area allows fluids to pass thru valve without creating turbulence — friction loss is reduced to a minimum. Resilient synthetic rubber seat against hard chromium plated floating ball forms a tight seal — stays tight! Quarter turn quickly and easily opens and closes valve under pressure. Valves can be installed in any position.

Remember, Rockwood Cast-Steel Ball Valves are Engineered for dependability — designed and built for longer trouble-free service. Call your nearest distributor or write direct to Rockwood Sprinkler Company for complete information and prices. Rockwood Valves are available in Cast-Steel in 3" & 4" pipe sizes — in bronze ½" to 2" pipe sizes.

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SPRINKLER COMPANY
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ROCKWOOD

WELDING LABORATORY—Center of research covering electrodes, procedures, processes, and equipment. Special equipment is available to determine the best procedures for shop and field welding. Extensive tests are made to adapt new procedures to automatic, as well as manual application.

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SPECTROGRAPHIC and X-ray diffraction equipment is used for exacting analysis of materials and manufacturing processes. They are also used in special investigations relating to heat exchanger research projects.

PHYSICAL LABORATORY—This laboratory has complete facilities for performing tests necessary to determine exact physical properties of all steels and alloys used in heat exchanger manufacture.

A. O. Smith Heat Exchangers

for every service!

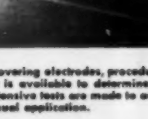
Your heat exchanger problems are solved at A. O. Smith by top-flight engineers and technicians in metallurgical and welding research and by specialists in heat exchanger design.

The quality of the materials selected is maintained by meticulous control procedures in our spectrographic and physical testing laboratories.

Heat exchangers are made and assembled under strict shop quality control, using the most modern machine tools and other mechanical equipment. A. O. Smith has the experience and equipment to perform any necessary test before the finished exchanger is shipped.

There is no limitation on A. O. Smith heat exchanger sizes, temperature or pressure ranges except those imposed by the properties of the materials used.

INDUSTRY COMES TO A.O.SMITH WITH HEAT EXCHANGER PROBLEMS



Research and Engineering Building

78th ANNIVERSARY 1874 1952

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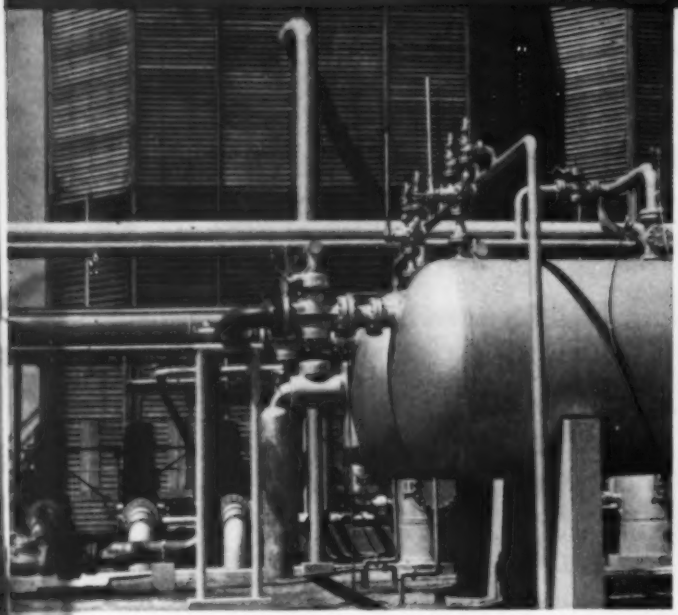
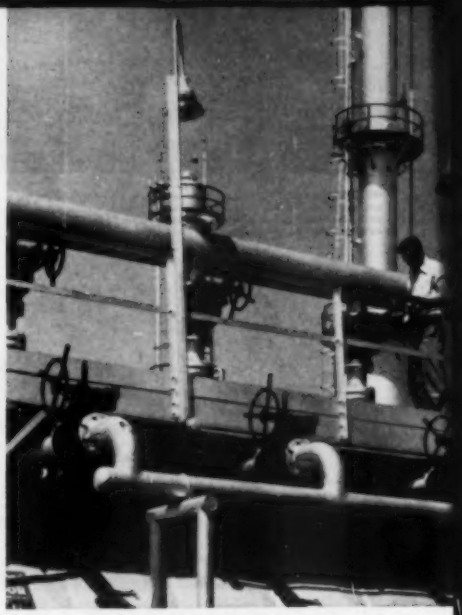
Q: Where are Nordstrom Valves



TREATERS— Manifold of Nordstrom valves on Perco gasoline treaters which take hydrogen sulphide and other impurities out of gasoline.

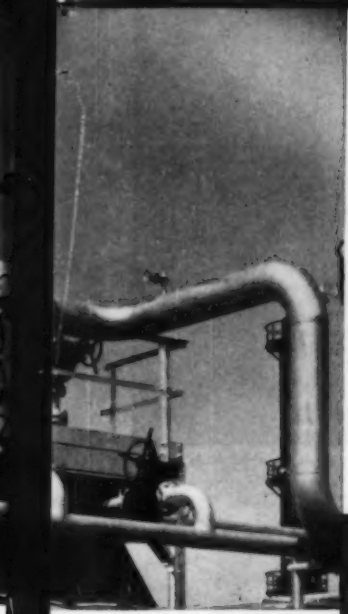


COOLING TOWERS— Lines carrying gas vapors to debutanizer overhead cooler are fitted with Nordstroms.

PUMP LINES— Insulated Nordstrom valves used on pump intake and discharge processing lines.

TANK STORAGE— Battery of Nordstrom valves control flow of gasoline, butane, and propane from storage to loading racks.

Used in a Gasoline Plant?



For the varied services in a gasoline plant Nordstroms are by far the most commonly used valves. Typical locations for Nordstrom valves are debutanizer, instrument, pump, dehydrator, scrubber, separator, treater, absorber, lean oil, deethanizer, oil heater, cooling tower, metering, compressor, gathering, storage and loading rack lines, to mention only a few.

Because Nordstrom valves are built for all pressure-temperature conditions encountered in a gasoline plant, because the range of Nordstrom sizes, materials and body styles is the most complete obtainable, because Nordstroms stay tight in service on hard-to-hold gases and petroleum derivatives, most of today's most efficient gasoline plants have standardized on Nordstrom lubricant sealed valves.

Here are just a few examples of the hundreds of Nordstrom applications in a *single Oklahoma gasoline plant.*

Where are Nordstrom Valves used in a Gasoline Plant?

A: Everywhere!

INSTRUMENT AIR LINES— Nordstrom valves on lines carrying instrument air to the air starting tank.

SURGE LINES— Rich oil from absorbers flows through these Nordstrom equipped lines to rich oil surge tanks for mixing.

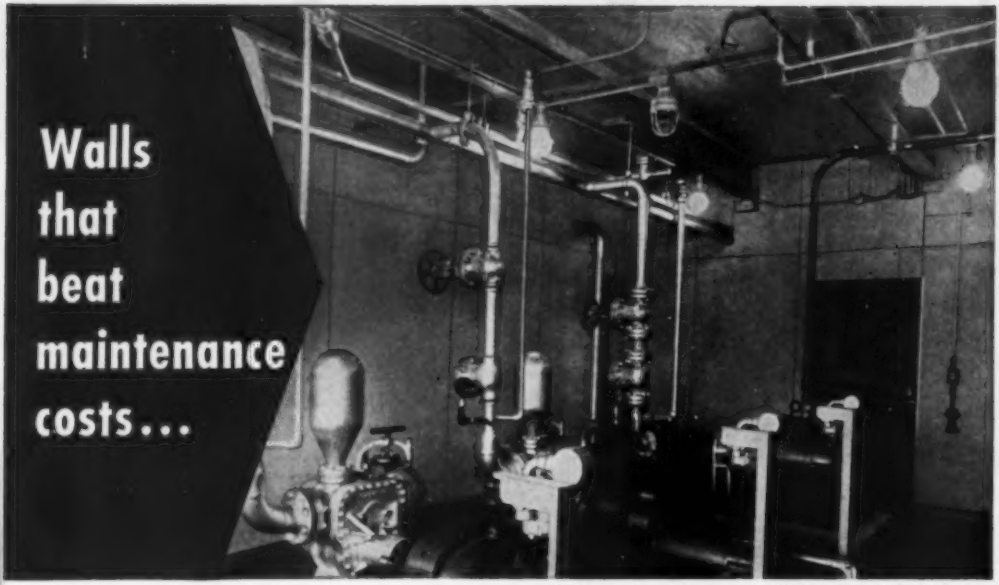
Nordstrom Valves

LUBRICANT SEALED TO KEEP UPKEEP DOWN

Another ROCKWELL Product

Rockwell MANUFACTURING COMPANY

400 N. Lexington Ave., Pittsburgh 8, Pennsylvania



Water treatment room in large utility plant. Walls are "Century" APAC, 5/8" thickness.

they're "Century" APAC!

In the water treatment room above you see how to build walls that won't need maintenance: Use "Century" APAC—Keasbey & Mattison's versatile asbestos-cement structural sheet. APAC can fill nearly all your surface covering needs . . . interior walls and ceilings . . . exterior walls . . . on new structures and modernizations.

CONSIDER THE ADVANTAGES OF APAC:

APAC won't burn! Made of asbestos fibers and Portland cement—both inorganic—APAC will not support combustion . . . makes an excellent fire-retardant barrier!

APAC is maintenance free! It cannot rot, rust, or corrode—rodents and termites can't hurt it. APAC doesn't even need protective painting to preserve it!

APAC is easy to handle—easy to apply! Can be cut and fitted on the job—no milling or planing to bother with. Large-size sheets (standard 4' x 8') facilitate rapid coverage. Can be fastened with ring fettered nails or screws. Application labor costs are kept to a minimum!

You'll find "Century" APAC used today in hundreds of plants, in dozens of industries: For siding, office paneling, fire-resistant sheathing in shops and stockrooms, storage bins, linings for elevator casings, shower stalls—in fact, wherever quick, economical construction and maintenance-free service are wanted. Write us for complete information on "Century" APAC and the name of your nearest distributor.

KEASBEY & MATTISON

COMPANY • AMBLER • PENNSYLVANIA

Nature made Asbestos . . . Keasbey & Mattison has made it serve mankind since 1873

K&M best in asbestos

In Canada—ATLAS ASBESTOS CO., LTD., MONTREAL, TORONTO, WINNIPEG, AND VANCOUVER

Why Ingersoll-Rand

VERTICAL PUMPS

are HIGH in performance

and LOW in installation and maintenance

OPERATION IS BETTER

These rugged, vertical process pumps have repeatedly proved their dependability and unusually high economy in services the world over. The shaft and impeller assembly is in complete radial balance. And positive alignment is maintained by accurate machined fits of all mating sections. The proven design of these units—with each part of the most suitable material for the application—assures *sustained* high efficiency.

INSTALLATION IS EASIER

The in-line arrangement of suction and discharge nozzles permits simple, straight-through piping—without loops or elbows. Piping can be located above or below floor level, as desired. Compact, vertical design conserves space—eliminates the need for large foundations, bedplates and grouting.

MAINTENANCE IS SIMPLIFIED

There is only one stuffing box—easily accessible through openings in the discharge head. Either conventional packing or the I-R Cameron Shaft Seal can be used. There is no thrust bearing to maintain, residual thrust being taken by the motor bearing. And the segmented inner casing assembly is easy to dismantle and assemble for inspection or servicing. Maximum interchangeability of impellers and diffusor sections reduces spare parts inventories.

The inherent advantages of vertical design particularly suit these pumps to many chemical and process services. Your nearest Ingersoll-Rand branch office engineer will be glad to study your next pumping problem with you. Whether the solution indicated calls for a vertical or horizontal unit, you are assured of obtaining the *right* pump for the job when you specify Ingersoll-Rand.

Ingersoll-Rand

CAMERON PUMP DIVISION
11 Broadway, New York 4, N. Y.

588-10A

THERE'S AN I-R CENTRIFUGAL PUMP FOR EVERY PROCESS NEED

Single-stage, vertically split
Capacities—20 to 550 gpm
Pressures—to 300 psi

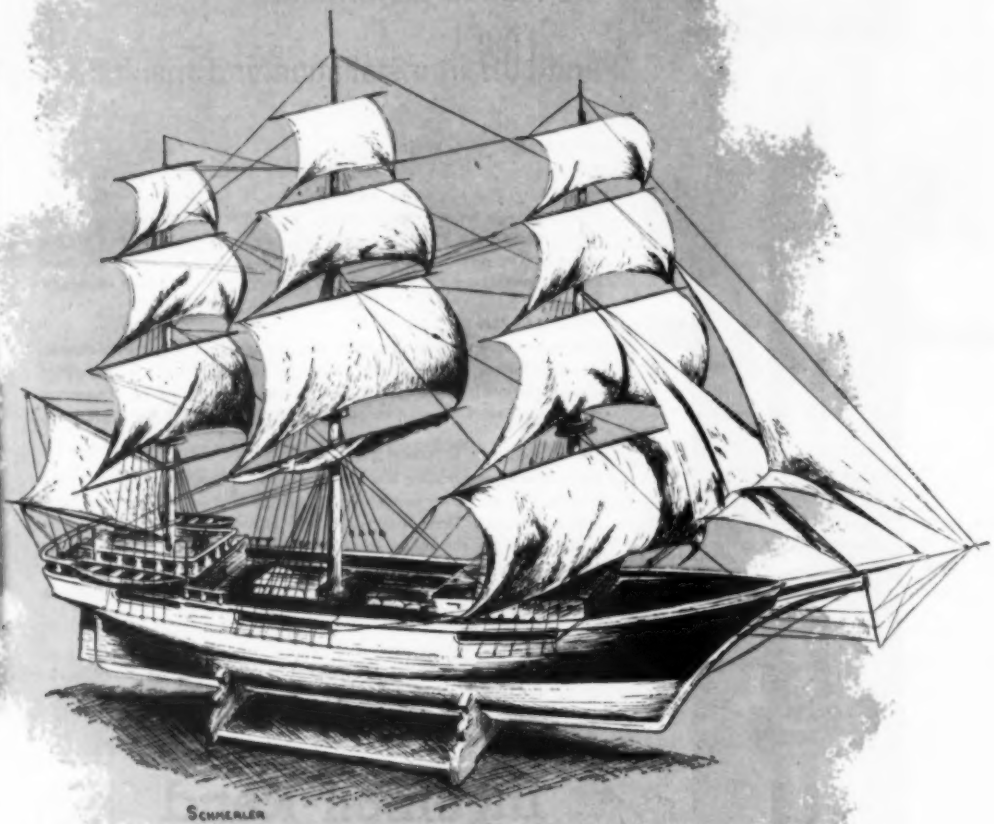
Single- and two-stage, vertically split
Capacities—10 to 3000 gpm
Pressures—to 600 psi

Single- and two-stage, horizontally split
Capacities—20 to 3500 gpm
Pressures—to 500 psi

Multi-stage, with cylindrical "double-case" construction
Capacities—to 2800 gpm
Pressures—to 3000 psi

COMPRESSORS — — AIR TOOLS — ROCK DRILLS — TURBO BLOWERS — CONDENSERS — CENTRIFUGAL PUMPS — DIESEL AND GAS ENGINES

FROM STEM TO STERN



ANOTHER WAY OF SAYING UOP SERVICE IS COMPLETE

Long before the fast clipper ships raced 'round the world for commercial prizes, sailors were saying "stem to stern" and "truck to keel" when they wanted to convey the idea of *completeness*. Today these salty terms are commonly used to express the same idea.

Even more accepted is the association of this thought with UOP Service. Included are all phases of basic petroleum research and process design, engineering, construction supervision, operator training and safety inspections, and assistance on day-to-day problems of plant operation.

UOP Service goes all the way to help licensee refiners operate their plants at greatest efficiency and profitability.

UNIVERSAL OIL PRODUCTS COMPANY

General Offices: 310 S. MICHIGAN AVE., CHICAGO 4, ILLINOIS, U.S.A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery

we can handle any job!

That's right, mister.
If it's process construction . . . we can handle it!

Procon has the broad range of experience plus the necessary flexibility to give you the advantages of a practical and efficient construction service covering all types of processing facilities.

For example, current jobs include fluid cat crackers . . . Platforming units . . . fractionators . . . vis-breakers . . . aromatic extraction units . . . gas recovery systems . . . and other types of processing units and plants.

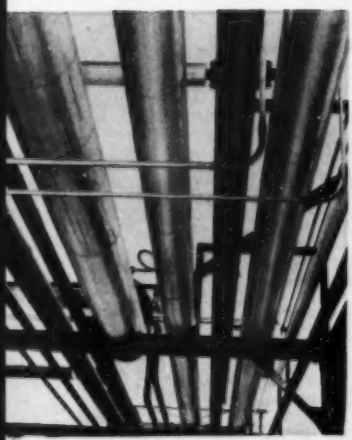
This partial list is certainly an indication of Procon's ability to handle any type of process construction work.

PROCON *Incorporated*
PROCESS CONSTRUCTION
75 EAST JACKSON BLVD., CHICAGO 4, ILLINOIS

Refineries cut maintenance on insulated lines by switch to new low-cost aluminum jacketing

"It cut jacketing application costs, and we expect it to last for years," report engineers at refineries everywhere after testing Childers Aluminum Jacketing on their insulated lines. This new Oklahoma refinery used Childers 100% — on towers and vessels (in heavy weight) as well as on lines. It is flexible and easy to put on, and this 35 alloy aluminum is tough and weather-resistant, even in corrosive industrial atmospheres. This is the first and only jacketing especially engineered for process plants and power installations.

At least 567 processing plants have installed and tested this new Childers Aluminum Weatherproof Jacketing during the last three years. You can examine its advantages for your plant by writing for a free sample. Address Childers Manufacturing Co., Dept. PR-8, 625 Yale St., Houston 7, Texas.



These lines are insured for years against wear and weather. They'll never need painting because Childers Jacketing gives them all the advantages of appearance and long life that come only with weather-resistant aluminum. Yet this specially engineered jacketing costs far less than would heavy aluminum sheets.

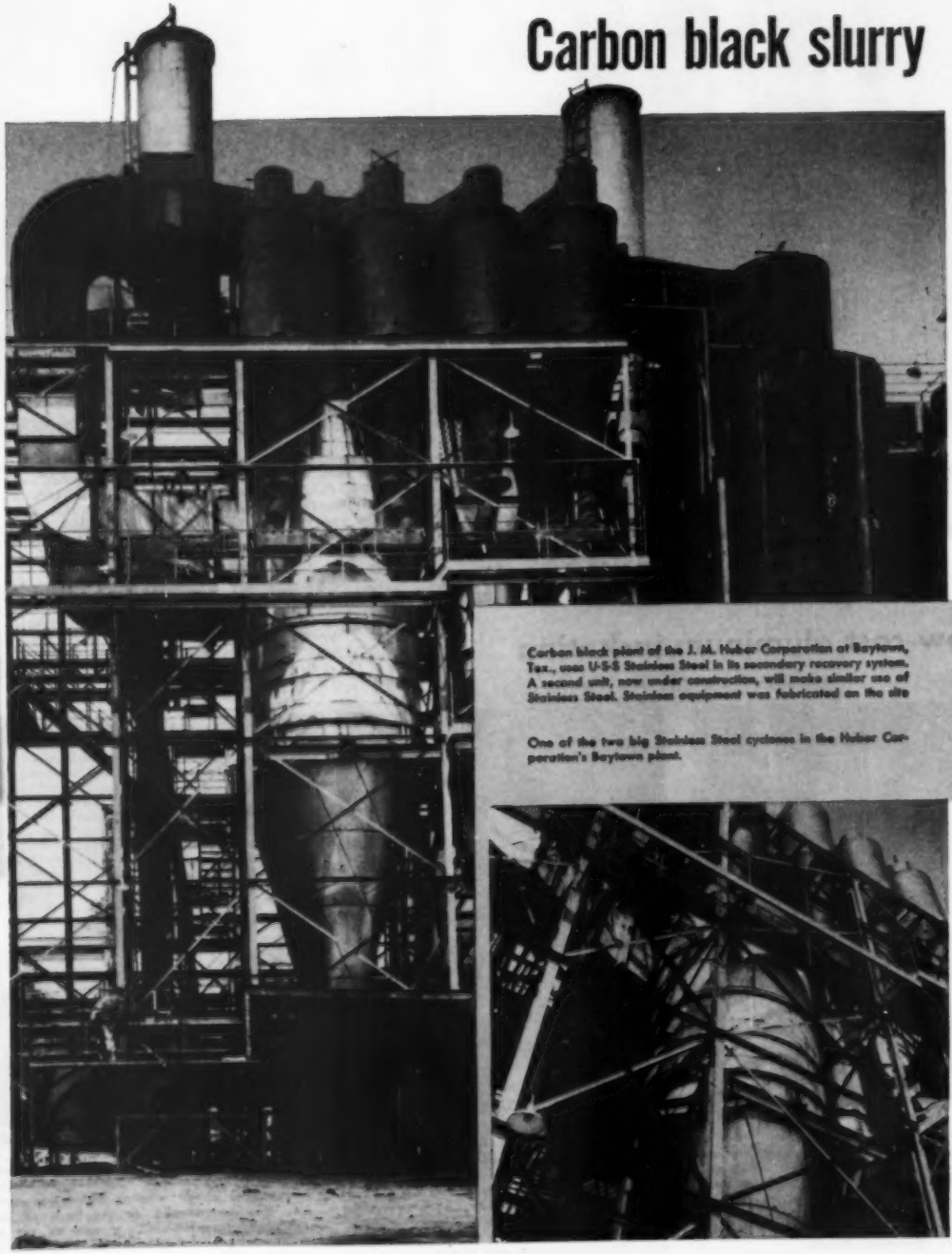
As shown here, Childers Jacketing can be attached with no more tools than a pliers and a wooden wedge. No expensive shop work or pre-forming are necessary. Several methods of attaching are available, but aluminum bands shown here are probably best and cheapest. Because this jacketing is so easy to handle and so simple to attach, it cuts installation costs way down.

This is how the flexible, easy-to-handle Childers Jacketing arrives at the job site. It is in convenient rolls 4 feet wide and 100 feet long—just right for one man to handle—and is available either with or without a moisture barrier attached on the back of the .006" aluminum "skin". It can be cut to proper lengths using any flat table and a straight-edge.

Advertisement

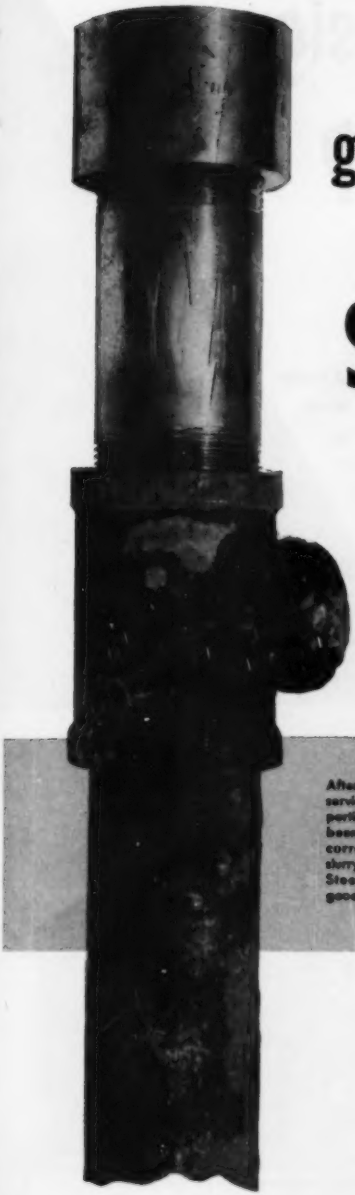
Under CMP regulations, Childers is a Class B product, the use of which is not restricted.

Carbon black slurry



Carbon black plant of the J. M. Huber Corporation at Baytown, Tex., uses U-S-S Stainless Steel in its secondary recovery system. A second unit, now under construction, will make similar use of Stainless Steel. Stainless equipment was fabricated on the site

One of the two big Stainless Steel cyclones in the Huber Corporation's Baytown plant.



After only three weeks in service, the non-Stainless portion of this piping has been completely ruined by corrosive carbon black slurry, while the Stainless Steel section remains in good condition.

gives equipment the acid test ... and only Stainless Steel survives!

ONE GLANCE at this section of piping tells you why Stainless Steel was a must for the secondary recovery system in J. M. Huber Corporation's carbon black plant at Baytown, Texas. After only three weeks of service, the non-Stainless portion is completely eaten through, while the part made of Stainless Steel is relatively unaffected by the extreme corrosion.

In order to get maximum recovery of the carbon black produced in converters at this plant, the Huber Corporation installed a secondary recovery system. The secondary system includes dry and wet recovery, and it's in the wet end where corrosion takes its heaviest toll.

The Huber Corporation tested many types of materials, plus many different kinds of coatings, before selecting U·S·S Stainless Steel for wet recovery. Stainless Steel was used for the two cyclones—each 12 feet in diameter and 42 feet high—for the sprays inside the cyclones and the piping through which the corrosive slurry passes.

In this application, U·S·S Stainless Steel is subjected to sulfuric acid, carbonic acid and other acids. Temperatures range up to 180°. Stainless Steel is standing up under these conditions where other materials failed after two or three weeks' service at the most.

The severe service conditions under which chemical processing equipment operates often preclude the use of anything but Stainless Steel. Stainless Steel's resistance to high temperatures and extremely corrosive conditions, its strength with light weight and its freedom from product contamination mean long equipment life with less maintenance and less frequent replacement.

Some grades of Stainless Steel are in limited supply today, but essential needs are being filled. For finest performance, insist that your fabricator use perfected, service-tested U·S·S Stainless Steel.

U·S·S STAINLESS STEEL

2-119

USS UNITED STATES STEEL COMPANY

AMERICAN STEEL & WIRE .... COLUMBIA-GENEVA STEEL .... NATIONAL TUBE .... TENNESSEE COAL & IRON

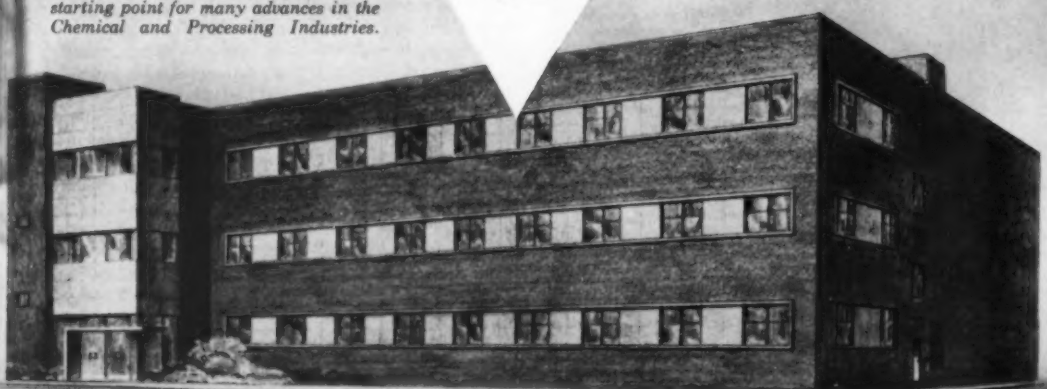
UNITED STATES STEEL SUPPLY, WAREHOUSE DISTRIBUTORS .... Divisions of UNITED STATES STEEL COMPANY, PITTSBURGH

UNITED STATES STEEL EXPORT COMPANY, NEW YORK

This team can design, build and equip your plant!

Here is a team unique in the chemical and processing fields . . . a team of imagination and ingenuity, with years and years of experience in all phases of engineering. Thoroughly capable of carrying through any undertaking from flow sheet to turn-key operation—on a basis of unified responsibility. Big enough for the biggest job . . . flexible enough for *any* job. This team can competently and economically translate your ideas into an operating plant.

New Chemical Plants headquarters . . . starting point for many advances in the Chemical and Processing Industries.



CHEMICAL PLANTS DIVISION

BLAW-KNOX CONSTRUCTION COMPANY

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REPUBLIC UPSON ALLOY STEEL STUDS

Where there's stress and heat and corrosive atmosphere, Republic Upson Alloy Steel Studs hold tight and give long, trouble-free service.

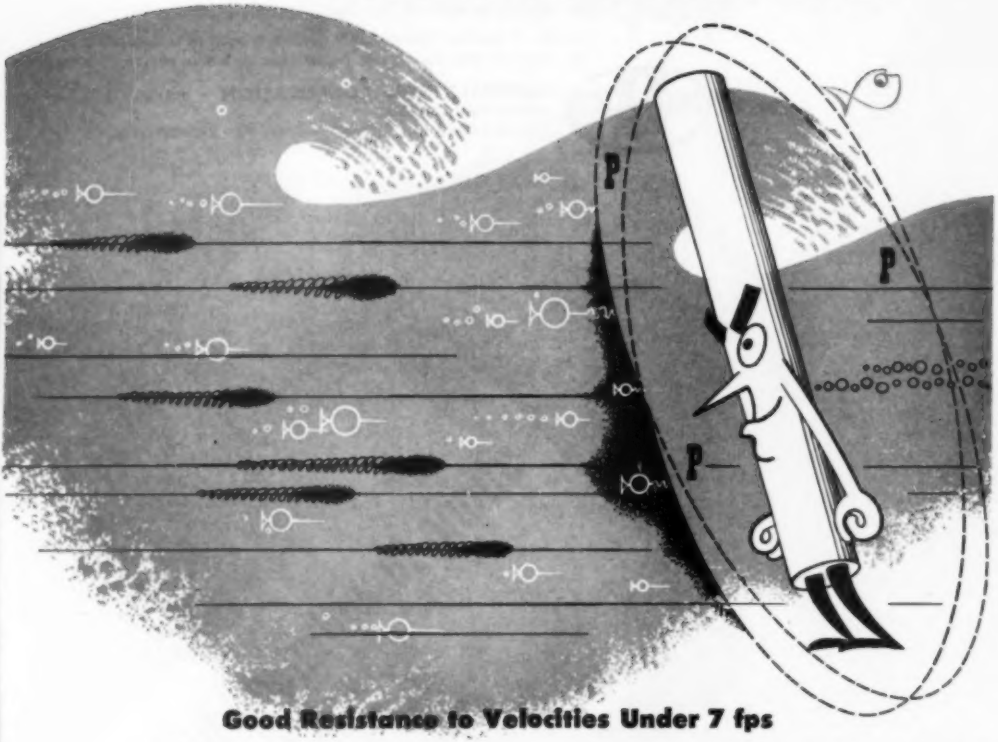
They're precision-machined from service-proved alloy steels produced by Republic, the world's leading producer of alloy steels. They fit-up tight, stay tight, yet are easy to turn-off for equipment maintenance.

Specify Republic Upson Alloy Steel Studs on new equipment . . . use them as trouble-saving replacements when you're overhauling.

REPUBLIC STEEL

REPUBLIC STEEL CORPORATION • *Bolt and Nut Division*
CLEVELAND 13, OHIO
Export Department: Chrysler Building, New York 17, New York

Why Phosphorized Admiralty Heat Exchanger Tubes?



Good Resistance to Velocities Under 7 fps

In order to assure *uniform* chemical composition and *soundness*, Scovill produces Phosphorized Admiralty tubes by its continuous billet-casting process which consistently maintains the optimum amount of phosphorus. Adding as little as 0.02% Phosphorus to Admiralty also gives maximum resistance to dezincification while retaining all the other desirable properties of this alloy.

Scovill's 40-page Condenser Tube Booklet is available to users who request it on their business letterhead. Scovill Manufacturing Company, 14 Mill Street, Waterbury 20, Connecticut.

Only Scovill Phosphorized Admiralty Has All These Advantages . . .

- Uniformity and soundness resulting from Scovill continuous-casting techniques
- Relative immunity to dezincification
- High resistance to sulfides and other active sulphur compounds
- Satisfactory resistance to weak mineral acids and acid mine waters
- Good resistance to velocities under 7 fps
- Excellent performance at relatively high operating temperatures
- Superior performance in fresh, salt or brackish waters

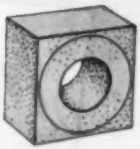
SCOVILL

A PRODUCT OF SCOVILL

SCOVILL HEAT EXCHANGER TUBES

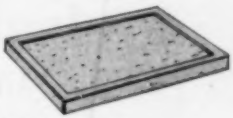
"You can't buy better brass"

We're finding new uses every day for versatile **KAOCAST**



KAOCAST Burner Blocks

KAOCAST Covering for Water Cooled Furnace Tubes



KAOCAST Door Lining

KAOCAST Car Top

KAOCAST Boiler Baffles

Even our Field Engineers are surprised to discover the amazing variety of uses for versatile Kaocast. This unique 3000 degree refractory castable has been put to work in scores of imaginative applications where it has paid off in lower installation costs, faster repairs, longer service life. Here are a few examples:

- **Kaocast replaced firebrick in door linings... lasted 3 to 6 times as long, cut costs in half.**
- **In a tunnel kiln, ordinary castables used for covering car tops crumbled after a few trips. Kaocast stayed on the job for 30 trips without deterioration.**
- **Versatile Kaocast proved "better than anything previously used" for piers of a stoker-fired boiler.**
- **This jack-of-all-refractories performs so well that one central station keeps a large stock on hand for miscellaneous jobs.**

Are you missing a money-saving opportunity to use versatile Kaocast? Ask your B&W Field Engineer to give you additional facts and figures . . . to help you profit with Kaocast. • KAOCAST is another important refractories development by B&W engineers who have continuously established new standards in industrial furnace refractories for the past 30 years.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: AUGUSTA, GA.

W-604

B&W REFRACTORIES PRODUCTS—B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick B&W Refractory Castables, Plastics and Mortars • OTHER B&W PRODUCTS—Stationary & Marine Boilers and Component Equipment... Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

NEW!

Measure and Control

Temperature
Pressure
Level
Flow
Flow Ratio

Speed
Conductivity or pH
Per Cent Oxygen
Per Cent Combustibles
Motion or Position

with STANDARDIZED Electronic Instruments

Standardized Bailey Electronic Instrument for indicating, recording and controlling the factors listed above.

FEATURES

1. Sustained accuracy and stability insured by careful design and the use of the null balance principle.
2. Trouble free service insured by sturdy Electronic Detector which replaces moving parts and delicate instrument suspensions.
3. Comparison of related factors made easy by continuous records of as many as four factors on a single chart.
4. Maintenance simplified by easy access to all parts and by exchangeable unit assemblies.
5. Attractive control panels assured by identical styling of all recording instruments.
6. Panel space saved by installing two controllers in one instrument.
7. Choice of three controls—air, on-off electric, modulated electronic.
8. Easy installation—no careful leveling or protection against vibration.

Ask for Bulletin 231

BAILEY METER COMPANY
1043 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE FLOW
PRESSURE LEVEL
% OXYGEN DENSITY
% COMBUSTIBLES RATIO

P11

A "K" Monel doctor blade in use on a soap flaker dryer roll. After 7 months of highly satisfactory service, this blade was transferred to rolls used for polishing soap, setting a record for doctor blade longevity in the plant.

The Doctor Was a Headache

...until they tried "K" MONEL

In a soap flake plant, flaker roll doctor blades were a source of considerable trouble and expense.

The blades were operated against a cast iron cooling roll, 5 ft. in diameter with a 90 in. face, which handled 72,000 pounds of soap every 24 hours.

Although made of the finest Swedish steel, doctor blades had to be honed every hour, and reground every 24 hours. It took only ten minutes to change a blade, but in that short time 500 pounds of soap production were lost.

After putting up with the problem for some time, plant engineers decided to try doctor blades made of "K" Monel®.

Results? Judge for yourself! Here is what the plant engineers reported:

1. *"K" Monel doctor blades (0.031 in. thick by 4 in. wide) required honing only once in 24 hours.*
2. *"K" Monel blades gave 27 continuous days of service before needing regrinding.*
3. *It took more than 7 months to reduce the width of a "K" Monel blade from 4 in. to 2¾ in.*

Switching to "K" Monel doctor blades gave them 24 times more service between honings, 9 times more service between regrinds, and saved uncalculated production poundage formerly lost through frequent blade changes.

Not always, of course, can such spectacular gains be made merely by changing the material of a doctor blade. But here's something to remember —

There are special INCO Nickel Alloys for almost every doctor blade application . . . alloys that have a proved record of reducing maintenance costs and speeding production.

Find out more about these important alloys by asking for your copy of: "How to Get More Production from Doctor Blades." Right now, of course, INCO Nickel Alloys are being diverted more and more to defense production, so you may have to wait for the metal you want.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS

MONEL® • "K"® MONEL • "KR"® MONEL • "R"® MONEL • "S"® MONEL
NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"®

To get all the benefits

of Fluid Catalytic Cracking

at lowest initial cost!

Kellogg Orthoflow

THE CRACKER WITH STRAIGHT-LINE CATALYST FLOW

This cross section reveals the simplicity of the Orthoflow design. Note straight line catalyst flow . . . specially-designed valves controlling flow of catalyst and oil.

Two new Kellogg Orthoflow units have now been on stream for hundreds of days . . . a third will start operating soon . . . and more are in the engineering and initial construction stages. Although each unit is designed for a specific operation, all have two things in common: the superior efficiency and economics of the Fluid bed and low investment cost.

Superior efficiency and economics are expected of any Fluid catalytic cracking operation—but these units have an additional edge in this respect because built into them is Kellogg's entire experience, culled from engineering more than 50 Fluid units in a period of ten years . . . more than 70% of the world's total Fluid cracking capacity.

Low initial cost is also to be expected of this new Orthoflow design. *One* vessel containing both reactor and regenerator. Less steel work. Smaller foundations. Shorter and fewer catalyst carrier lines. No slide valves. Elimination of expansion joints in the catalyst transportation system.

Such features are bound to reflect favorably on investment costs. But in addition, these Kellogg engineering advances offer decreased maintenance cost because of straight line transmission of catalyst-oil mixtures and spent catalyst. Only the Orthoflow has this erosion-reducing feature. Only the Orthoflow has eliminated the maintenance problem of expansion joints, utilizing specially-designed spring-loaded valves to absorb thermal expansion.

If you are considering the addition of Fluid catalytic cracking to your processing sequence or an increase in your present cracking capacity, you should explore the advantages of the new Kellogg Orthoflow converter.

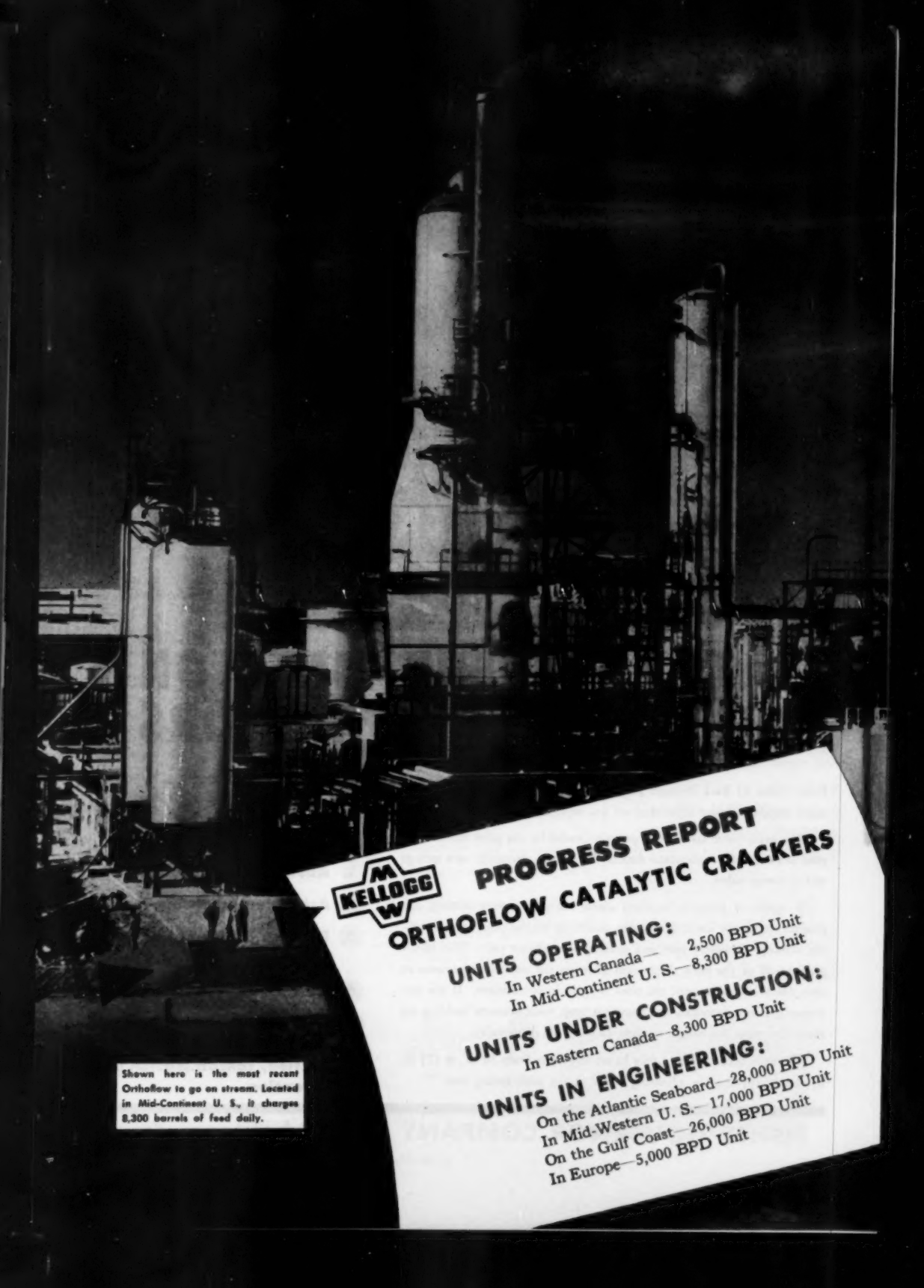
THE M. W. KELLOGG COMPANY

(A Subsidiary of Pullman Incorporated)

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

KELLOGG

for fifty-one years an integral part of petroleum refining progress!



Shown here is the most recent Orthoflow to go on stream. Located in Mid-Continent U. S., it charges 8,300 barrels of feed daily.

KELLOGG

PROGRESS REPORT
ORTHOFLOW CATALYTIC CRACKERS

UNITS OPERATING:

In Western Canada— 2,500 BPD Unit
In Mid-Continent U. S.—8,300 BPD Unit

UNITS UNDER CONSTRUCTION:

In Eastern Canada—8,300 BPD Unit

UNITS IN ENGINEERING:

On the Atlantic Seaboard—28,000 BPD Unit
In Mid-Western U. S.—17,000 BPD Unit
On the Gulf Coast—26,000 BPD Unit
In Europe—5,000 BPD Unit

. . . FOR VENT LINES ON OIL AND GAS SEPARATORS

Fisher Series 63 Back Pressure Regulators are used where pilot control, stable regulation, and tight shut-off are required.

The main valve assembly is pressure loaded by the pilot valve. The pilot consists of a connected double diaphragm assembly, two springs and a 3-way valve.

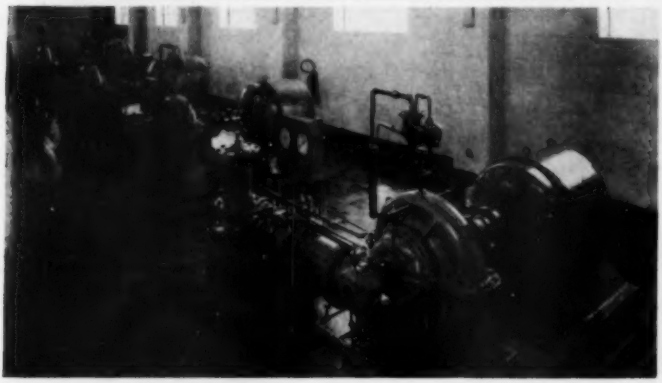
If upstream pressure increases above the pilot spring setting, the pressure under the lower diaphragm pushes up on the diaphragm assembly, closing the supply port and opening the exhaust port. This bleeds pressure off of the main diaphragm allowing the unbalance pressure to open the main valve until the pilot is again in equilibrium. If the upstream pressure decreases, the reverse is true, with pressure building up above the main diaphragm tending to close the main valve.

The back pressure range may be set anywhere from 10 lb. to 125 lb. by simply turning the adjusting screw in the pilot spring case.

Features

- **Absolute tight shut-off.**
- **Accurate and stable control.**
- **Full line orifice permits maximum capacity.**
- **Non-bleed type of pilot.**
- **Teflon stem seal eliminates lubrication and reduces friction, contamination and attention.**

FISHER GOVERNOR COMPANY • Marshalltown, Iowa



A Plan That Gets the Most out of Centrifugal Pumps

Easy-To-Install Maintenance Program Means Better Performance, Longer Life

You can't get maximum production when your equipment's operation is constantly interrupted due to breakdowns. Moreover, today's equipment shortages make it increasingly more important that you get all the life you can out of your present machines.

We'd like to suggest a maintenance plan that will help you get the most out of one of your most vital pieces of equipment—centrifugal pumps.

Keep Informative Records

If you haven't already done so, it's a good idea to begin your maintenance plan by setting up a card index file so that you can catalogue each pump in your plant. Each card should contain the following information: plant pump number, size, manufacturer's name and style, serial number, date installed, and any other data which will help you to rapidly locate repair parts lists and manufacturer's parts numbers.

The rest of the card can be divided into a number of columns: Repair Date, Part Affected, Remarks, and Cost. A typical card is shown here.

PUMP MAINTENANCE CARD

PUMP NO. _____ MANUFACTURER _____
SIZE _____ MFGR'S ADDRESS _____
DATE INSTALLED _____ MFGR'S SERIAL NO. _____
LOCATION _____ MFGR'S STYLE _____

DATE	PART	REMARKS	COST

If you're careful to enter every maintenance or repair operation on the proper card, it won't be long before each card indicates a particular pattern of maintenance.

Set Up A Maintenance Schedule

Once this pattern is established for all the cards, you can set up a schedule of maintenance points for such items as: packing, greasing or oiling, painting, gasket replacement, and bearing examination. You may find, for example, that a unit or group requires packing maintenance about once every three months, and greasing once every four to six months, etc.

Your next step is to arrange a plant schedule so that a particular pump may be shut down for maintenance at or before these times. Thus you make it possible to do the maintenance work under proper and unhurried conditions to assure maximum conformity of production consistent with long pump life. In addition, examination of the card catalogue will guide operating and maintenance personnel as to quantity of repair parts they should keep on hand.

Make Periodic Inspections Externally

It is considered *inadvisable* to open pumps for inspection.

Rather, recent practice is to let pumps stay on the line until such time as external aymptoms indicate overhaul may be required. These symptoms involve either a reduction in effective capacity because of wear at the internal clearance points or mechanical difficulties, such as vibration or noisy operation.

Parts requiring most frequent replacement in centrifugal pumps are: wearing rings, shaft sleeves, packing and bearings.

The most important maintenance point on process pumping equipment is the stuffing box. It must be kept clean, cool, and lubricated—but *packing* is the crucial operation. A good packing method will be discussed in a later edition of *Pointers on Pumps*.

Don't forget the frames, base plates, and supporting parts of your pumps. Good housekeeping often makes it easier to do a good overall maintenance job!

Can We Help You?

Worthington makes more *standard* pumps than any other manufacturer. Don't buy a "special" (at a higher price) without checking to see if Worthington makes it *standard*.

If you *do* need a special, remember Worthington's modern engineering facilities, backed by the longest and broadest experience in the field. Contact our nearest District Office or write to Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.

C.2.2

The World's Broadest Line Assures You the Right Pump for Every Job

WORTHINGTON
Centrifugal Pumps

WHAT SIZE AND STYLE OF BUBBLE CAP SHALL WE USE?

PSC Offers the Largest Choice of Standard Bubble Caps—ALL WITHOUT DIE COST

Any time you are in need of engineering data on bubble caps may we suggest that you refer to our Bulletin 21 or The Refinery Catalog. In both sources you will find the largest compilation of bubble cap and riser data in print, covering over 200 standard styles furnished by The Pressed Steel Co.

OVER 200 STANDARD STYLES

Should you find among our line of standard caps a style to meet your needs we can save you the cost of dies as well as make prompt delivery. As fabricators of the largest line of bubble caps, we offer you a broad experience in the production of special caps to meet specific refinery conditions. Send blue prints or write as to your needs.

Send for
BUBBLE CAP BULLETIN 21

The largest compilation of engineering data on bubble caps in printed form. Also drawings for use in determining methods of tray assembly. BULLETIN 31 describes LeJons assembly.

PRESSED STEEL PSC

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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A safety record is no accident

Setting a record is no easy job, but it's well worth the effort—especially when safety is involved.

We are proud of the part we have played in the oil industry's safety record. We are particularly proud that the system of safety precautions for the handling and mixing of "Ethyl" antiknock compound and the safe practices in tank-cleaning techniques which have been accepted and put into effect throughout the industry were pioneered by Ethyl safety engineers.

However, Ethyl safety engineers do a lot more than prevent accidents. They save refiners time and money, too. For example, they are constantly seeking new ways to save time and labor and to assure safe operation. This search has resulted in many improvements in mixing installations, tank-cleaning methods

(*Continued on next page*)

A safety record is no accident

(*Continued from preceding page*)

and has contributed to improvements in storage-tank design. One recent contribution is the "Ethyl" lead-in-air analyzer which quickly checks the amount of lead in the air at any moment—permitting the safe entry of tank-cleaning personnel.

Our engineers have broad experience in the construction, operation and maintenance of mixing plants. You can put this experience to work for you if you are contemplating the erection of new mixing installations or modernizing existing plants. Our trained men will assist you in the selection of a site, supply plans and specifications, and instruct refinery personnel in correct procedures for operating the new equipment. And when your plant is in operation, Ethyl's engineers help keep it working at top efficiency. They make periodic "check up" visits, assist with maintenance and help make modifications to meet changing conditions.

So you can see why we say "A safety record is no accident."

ETHYL CORPORATION

NEW YORK 17, N. Y.

Ethyl service is backed by 28 years of antiknock experience

RESEARCH

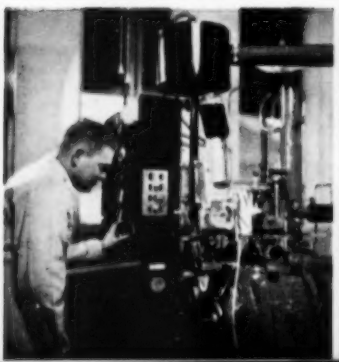
PREMIUM-GASOLINE PROMOTION

SUPPLY SERVICE

GASOLINE TESTING

TECHNICAL NOTES

ROAD RATINGS INDOORS



Siamese Twins!

S&J

- It's Shand & Jurs' combination Breather Valve and Gauge Hatch for small marketing and bulk plant tanks — Fig. ST-1615.
- Rugged all aluminum body houses both units and fits single 3" tank connection.
- Economical with high venting capacity and full 3" gauge hatch opening.
- Quick removable pressure hood for easy access to internal parts for inspection or maintenance.
- Screw down, soft seated, self closing and vapor tight gauge cover made of bronze.
- Breather Valve set for standard pressure loading of 4 ounces; ½ ounce for vacuum. Special settings available as required.

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VAPOR-TIGHT PLUG
VALVE
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Operates in 1¼ turns
NO! NO! No Lubrication
Retracting seats can't score walls
Facings as specified
Shuts off VAPOR TIGHT
235 to 5,000 P.S.I. Working Pressures
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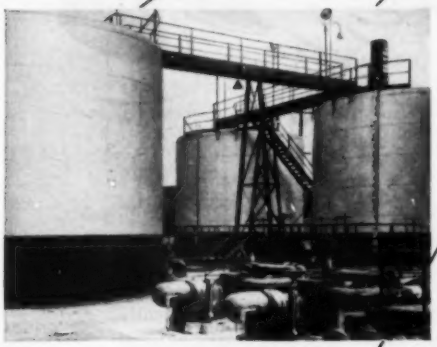
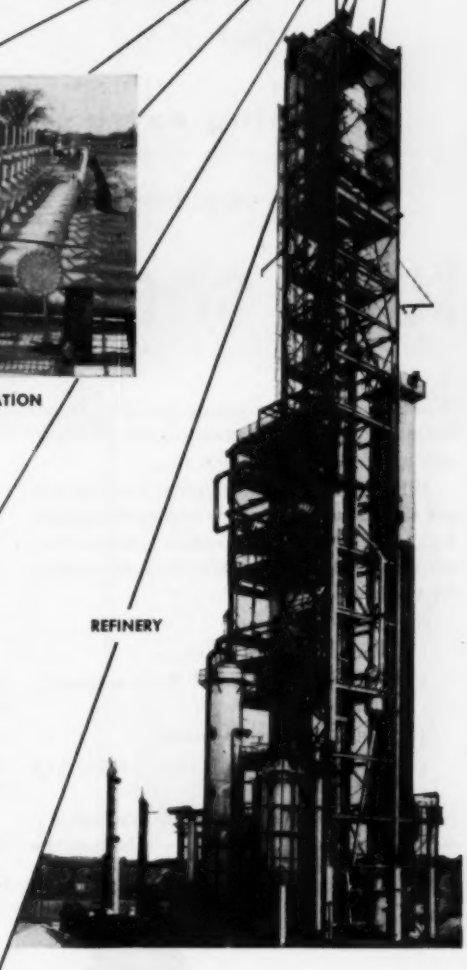
PUMPING STATION



BLENDING PLANT



REFINERY

Graver Construction Service provides the skill and facilities to cover full responsibility for the engineering, procurement, and erection requirements of refineries, blending plants, pumping stations, and pipe line terminals. This complete service applies to installation of new facilities . . . expansion of existing equipment . . . maintenance and repair.

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A DIVISION OF

GRAVER TANK & MFG. CO., INC.

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Get

something extra

when you buy

lead sheet

When you place an order for lead sheet, chances are you state quantity, composition, size and weight, and that's all.

When you buy from National, you not only get sheet that meets these four specifications but you also get certain "extras"—extras characteristic of the *high quality* lead sheet made by the leader in lead.

Such as

(1) A smooth, even finish.

(2) A surface as free of flaws as careful milling can make it.

(3) Uniform over-all gauge.

(4) Maximum structural strength throughout.

These extras contribute to adaptability, workability, and durability – whether the sheet is used for handling corrosives, for architectural installations, or for radiation barriers.

It is these extra qualities, not specifically stated in your order, that give National Lead sheet its dependability on the job.

That's why we say—when you want lead sheet—come to National. And get something extra.

Sheet Lead

with a **NATIONAL** reputation

LEAD COMPANY

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Limited)

*Reg. U. S. Pat. Off.

Leaving the STRESS where it belongs...

Stress relieving prefabricated piping with highly developed equipment and special techniques is one reason why exacting specifications are met with

GRINNELL PREFABRICATED PIPING

Grinnell received an order recently for stress relieving prefabricated piping to these specifications:—

> "All fabricated pieces shall be normalized and drawn by heating to a uniform temperature of 1700°F (plus or minus 25°F). This temperature shall be maintained on a basis of one-half hour for each quarter inch of wall thickness of the heaviest pipe in the furnace charge followed by air cooling not less than 600°F. All pieces shall then be reheated to 1425°F and held at temperatures as above. In no case shall the time be less than 2 hours . . . Cool at a controlled rate not to exceed 200°F per hour until 600°F is reached . . ."

Grinnell, of course, met these specifications precisely. In fact, fabricating industrial piping today demands the *maximum* in versatility and precision.

Modern power plants, for example, need piping of heavy cross-sectional area and definite alloy composition to provide high temperature stability, resistance to creep and graphitization. Chemical and oil refining processes, on the other hand, must have piping of high chrome alloy to impart strength at high temperatures, resist corrosion, withstand impacts at low temperatures. Heat-treating often is the only answer — either to restore properties affected during fabrication, or improve original properties.

GRINNELL'S AUTOMATIC HEAT-TREATING FURNACE

performs with positive efficiency. This versatile stress-relieving unit, measuring 12 by 12 by 40 feet and using gas or oil or both as fuel, was designed to give full program control for the entire range of working temperatures. It provides instrument control of rate of rise in temperature of the charge, length of time for holding at the predetermined temperature level, and cooling rate. Two recording controllers are provided for the furnace and a separate 6-point recorder registers the temperatures of the charge simultaneously during the treating cycle.

Exterior View of Building

In heat-treating, as in everything else for piping, Grinnell has the experience and the costly equipment to fully protect large piping expenditures. That is why it will always pay you to call on Grinnell for *all* of your piping needs.

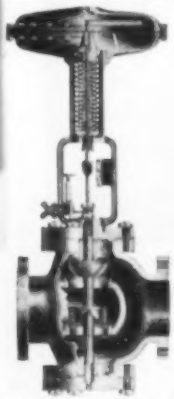
GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company Inc., Providence, Rhode Island • Sales Offices and Warehouses in Principal Cities

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermoflex unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco humidification and cooling systems

76 BS&B CLIMAX CONTROLS CENTERS



CLIMAX TYPE 86

Diaphragm Control Valve. One of the most widely used controls in the Climax line.

Your Fastest, Most Efficient Service

In 29 states and 3 Canadian provinces 76 BS&B Climax Controls sales and service centers are prepared to meet your needs for fast, efficient, convenient service on automatic controls for regulating flow, levels, temperature, pressure and power. From these centers, including 43 strategically located warehouse stocks of Climax Controls and parts, Climax sales engineers are quickly available to render service on existing equipment or to help you plan new installations.

The widespread, closely integrated Climax organization is a definite assurance that your machinery and processes will function at maximum efficiency and with minimum interruptions when equipped with BS&B automatic Climax Controls.

Climax Controls catalog will be sent to you promptly at your request.

CLIMAX BS&B CONTROLS

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division Dept. 4-F2

7500 E. 12th Street — Kansas City, Missouri

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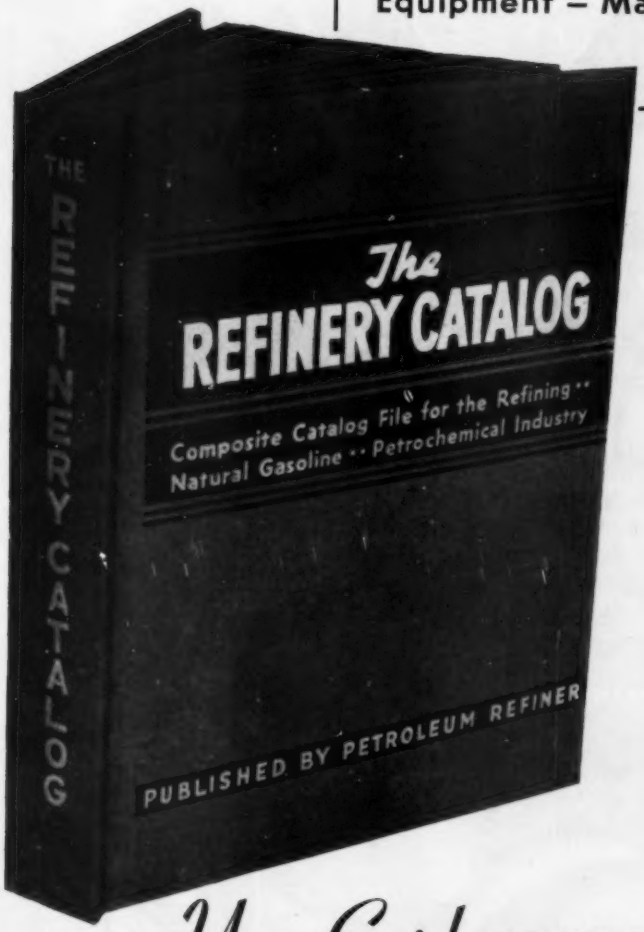
REFINERY CATALOG

Watch for this sign of Customer Service

BASIC SOURCE BOOK
for
REFINING INDUSTRY
Equipment – Materials – Processes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Composite Catalog File for the Refining • Natural Gasoline • Petrochemical Industry
PUBLISHED BY PETROLEUM REFINER

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Your Guide **TO WISE BUYING DECISIONS**

REFINERY CATALOG

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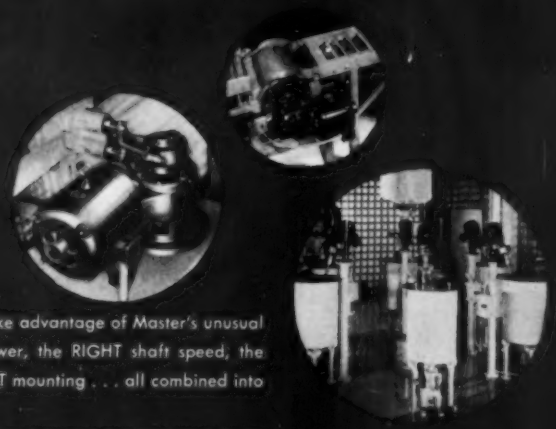
Published by Petroleum Refiner, P. O. Box 2608, Houston 1, Texas



On big jobs or little ones it pays to take advantage of Master's unusual ability to supply the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

Don't put up with make-shift assemblies when you too may be enjoying these advantages. Master Motors, available in thousands and thousands of types and ratings (up to 150 HP) give you a selection you can get nowhere else.

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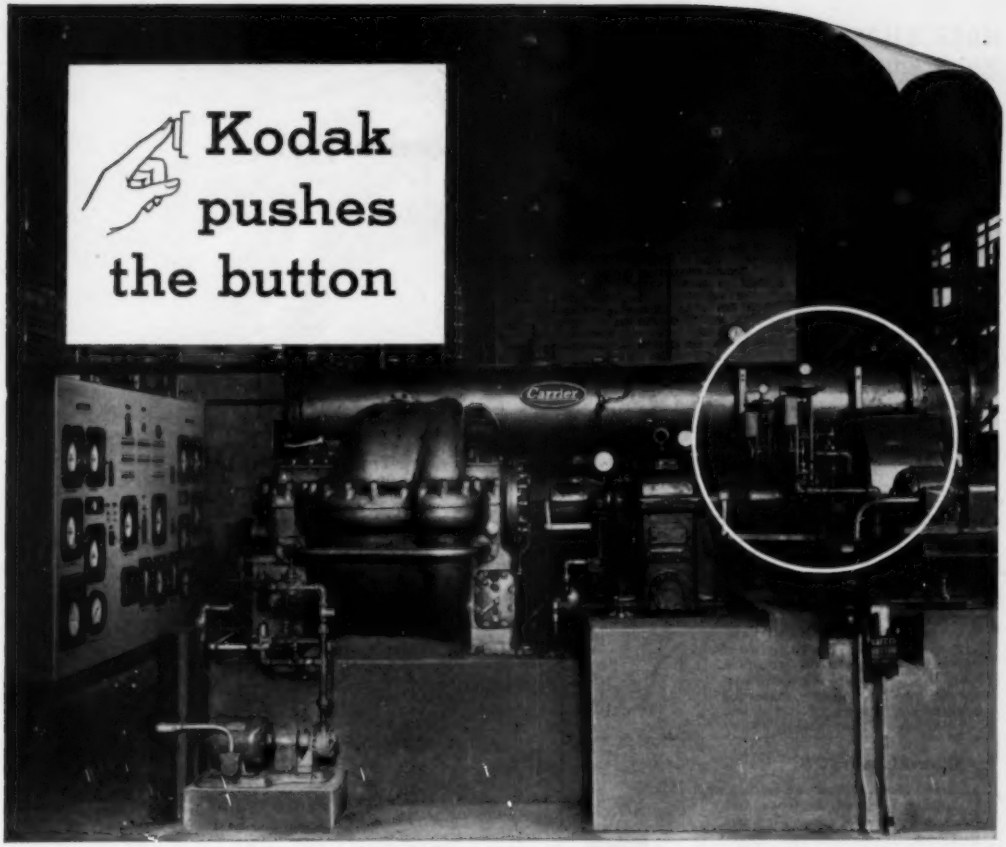
little ones or **BIG** ones

Select the RIGHT power drive from Master's broad line and you can increase the saleability of your motor driven products . . . improve the economy and productivity of your plant equipment.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO



We do the rest...

in controlling the refrigeration system at Kodak's huge new Distribution Center at Rochester, N.Y.

This center handles practically every Rochester-manufactured Kodak product for storage, packing and shipping. Efficient air-conditioning is extremely important in the storage of sensitive photographic films and papers.

The refrigeration unit, shown above, consists of two 250-ton Carrier centrifugal compressors driven by a constant speed electric motor. These compressors supply the chilled brine to the Taylor controlled zones.

Taylor controls keep the output temperature of the chilled brine constant by regulating the compressor speed through the oil volume in the hydraulic coupling (circled) between the compressor itself and a constant speed motor. During periods of minimum load, an ingenious hot gas by-pass induces a load on the compressors to eliminate surging and keep the system fully automatic. From Friday night to Monday morning, when the load is especially light, the system automatically keeps the brine temperature constant with *no manual attention* whatever. "The most fully automatic compressors we have ever installed" say Carrier engineers about these Taylor controlled centrifugals.

Whether your compressor is reciprocating or centrifugal—driven by an electric motor, steam engine, steam turbine, or gas, Taylor offers automatic compressor control. Ask your Taylor Field Engineer, or write for **Catalog 300.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

Now a new name

to start our second half century . . .

CHICAGO METAL HOSE CORPORATION

Flexonics *Corporation*

Sales operations are divided into four logical divisions

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Corrugated and convoluted flexible metal hose, machine tool conduit, refrigeration conduit, "Vibra-Sorber" vibration eliminators for piping, and assemblies for specific applications.

AIRCRAFT DIVISION

Stainless steel aircraft components including hose of all types, bellows, oil and fuel lines, air lines, ducting and connectors of all types and many special assemblies for jet aircraft.

FLEXON BELLOWS DIVISION

Stainless steel bellows, brass and bronze bellows, automobile thermostats and bellows and bellows assemblies and devices for all types of standard and specialized applications.

EXPANSION JOINT DIVISION

Standard corrugated packless type expansion joints in free-flexing and controlled-flexing construction, high pressure Flexoniflex expansion joints, heat riser expansion joints, and special joints.

• In 1947, Chicago Metal Hose Corporation introduced to industry a new science—the science of Flexonics. It is defined as the controlled bending of thin metals for use under varying conditions of temperature, pressure, vibration and corrosion. This definition so well describes our operations and the expanding range of our products that we are adopting it as our corporate name coincident with our 50th anniversary year.

Let us assure you, however, that the change from Chicago Metal Hose Corporation to Flexonics Corporation involves no change in management, personnel or methods of operation except for internal organizational changes that will make it possible for a fast growing company to serve its customers better.

Flexonics *Corporation* **1336 S. THIRD AVENUE · MAYWOOD, ILLINOIS**

FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies CMH products that have served industry for over 50 years.

Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals · Expansion Joints for Piping Systems · Stainless Steel and Brass Bellows · Flexible Metal Conduit and Armor · Assemblies of These Components

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Lasts longer in corrosive service

This bolted bonnet type Y valve, made to special order in a wide range of alloys, is especially engineered for severe corrosive service. Like all ALOYCO valves, its dependable performance results from: metallurgical research devoted exclusively to corrosive applications . . . foundry and machine shop facilities set up for high alloy valves *only* . . . casting and machining practices dictated by the difficult characteristics of the alloys required for corrosive services.

ALOYCO No. 361 Y Valve for 150 pounds service furnished in a wide range of alloys.

SUCCESS STORIES FROM ALOYCO'S CORROSION CLINIC

THE CORROSIVE: Sulfuric acid and sulfuric-sulfonic acid mixtures used in sulfonation process for manufacture of synthetic detergent.

THE PLACE: A large oil refinery.

THE VALVE: ALOYCO 20 #111-A gate valves.

THE RESULTS: Cast steel gate valves formerly used lasted only about six months. If valves were kept open most of time, they could not be closed when desired due to sulfating and corrosion around stem at stuffing box. ALOYCO valves installed over *two years ago* are still *operating freely* with minimum stuffing box leakage, at *low maintenance cost.* Both operators and maintenance men like ALOYCO valves for strong sulfuric acid service.

THE BACKGROUND: The cost and nuisance of frequent valve replacement have been eliminated in many applications throughout the petroleum industry by adoption of Aloyco corrosion-resistant valves especially developed for such services.

For example, as in this application, the unusually high nickel content which permits ALOYCO 20 to contain substantial amounts of molybdenum and copper, both highly effective in restraining sulfuric acid attack, is of utmost importance.

Such alloys are under constant study in ALOYCO's metallurgical laboratory, the *largest* ever devoted *exclusively* to the "diagnosis" and "treatment" of problems relating to valves in corrosive service. From the results of laboratory and field testing, it develops the specifications for customers' applications.

If your plant deals with severe corrosives or must guard against product contamination, put your problem before the *Aloyco Corrosion Clinic.*

ALOYCO valves resist the severe corrosive effect of sulfuric-sulfonic acid mixture at atmospheric temperature, 50 psi.

ALLOY STEEL PRODUCTS CO., INC.
1303 West Elizabeth Avenue, Linden, N. J.

Longer-Lasting
ALOYCO VALVES
1st in Corrosive Service

Stop Tar Separation

in diesel and fuel oils . . . use

IONAD 17

Shell's fuel oil additive saves money four ways for refiners:

1. Ionad 17 eliminates filter screen clogging . . . the largest single cause of service troubles in domestic oil burner equipment. Burner parts are also kept free of tars and resins.

2. Ionad 17 makes fuel oil stocks more compatible.

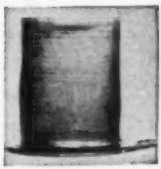
3. Ionad 17 minimizes treatment of fuel oil stocks. In many cases the cost of adding Ionad 17 is *more than paid for* by savings in reduced fuel oil treatment alone.

4. Ionad 17 prevents the accumulation of sludge on tank bottoms. As a result, tanks require less frequent cleaning.

Ionad 17 is a stable concentrate that is readily soluble in fuel oil stocks. It prevents the agglomeration of the tars and resins that form in most fuel oils from the polymerization of olefins. Its advantages are now available to refiners of fuel oils—get complete information from the nearest Shell Chemical office.

THE SAME FUEL OIL!

WITH IONAD 17



WITHOUT IONAD 17

Both filter screens operated for 28 days with No. 2 fuel oil.

SHELL CHEMICAL CORPORATION

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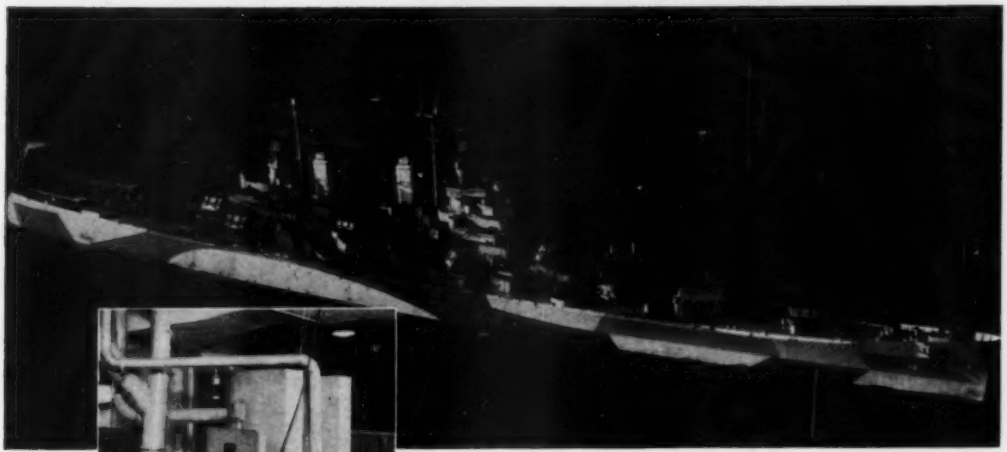
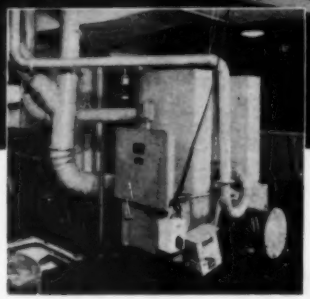
IONAD 17

Suppose YOU

had to "warehouse" a 13,000-ton cruiser . . .





The U. S. S. Pittsburgh, heavy cruiser, back at sea after having been kept in readiness with the aid of Pittsburgh Lectrodryers like the one shown at the left.

The Navy did it by making the ship its own warehouse. In "Operation Mothball" the hull was sealed tight against outside moisture and the relative humidity maintained below 30% with the aid of Lectrodryers*. Now "Operation Zipper" has put the Pittsburgh back in service, its vitals rust-free and corrosion-free.

To warehouse safely any goods that WETth (unwanted moisture) would spoil—depend upon Lectrodryer. A Lectrodryer will DRY your storage-space air continuously, economically, automatically. Lectrodryer* engineers will work with you to design your entire DRYing operation—including selection and installation of moisture-vapor barriers to control atmospheric WETth. Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pennsylvania:

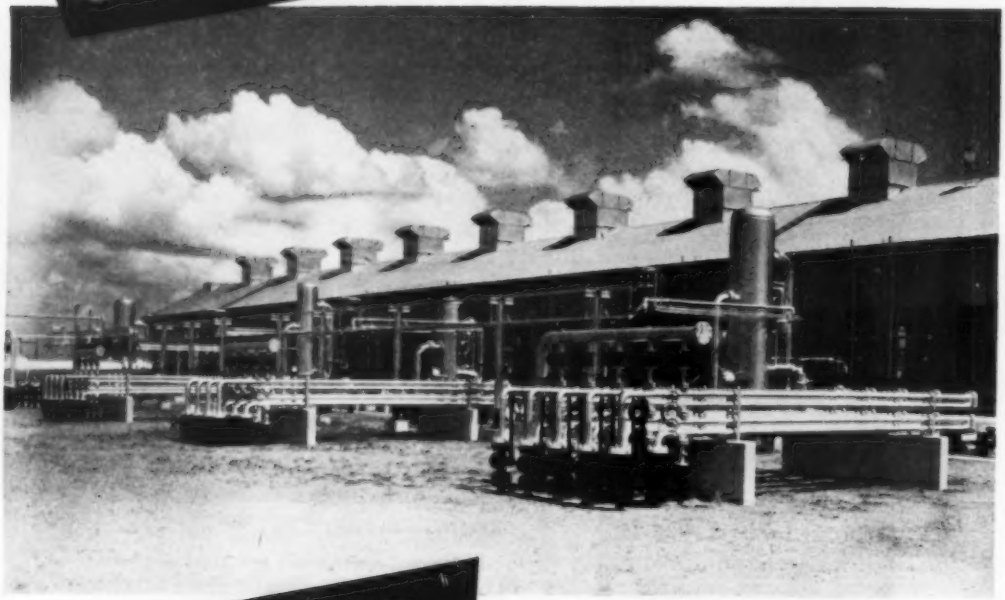
In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

Reduce Obsolescence in your plant



with **BROWN FINTUBE** *sectional hairpin heat exchangers*

● Brown Fintube's interchangeability of parts, exacting design and precision manufacture has "licked" obsolescence.

The sections can be used in one bank after another — on different duties — and different products. A bank can even be broken up and the sections shipped to two or more plants, miles apart, re-assembled and reused. Sections not in use serve as "stores" for other sections on stream. They are never obsoleted by changes in duty or plant re-arrangements. You can use and reuse them until they are completely worn out. Estimates and quotations furnished promptly. ***Write for Bulletin No. 481.***

THE BROWN FINTUBE CO.

Elyria, Ohio

Sectional Hairpin Heat Exchangers
Tank Suction and Line Heaters
Fintube Heaters for Bulk Storage Tanks
Indirect Process Air Heaters
Fintube Heaters for Processing Tanks
Integral Welded Fintubes for Any Heating, Cooling or Heat Transfer Service

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WHENEVER YOU SEE

furnaces like these, you can be sure they're* PETRO-CHEM ISO-FLOW *design

More than 935 are in operation throughout the world in the petroleum, chemical and allied industries . . . for all processes and for any duty, pressure, temperature and efficiency . . . and all Petro-Chem Iso-Flow furnaces are pre-eminently satisfactory.

PETRO-CHEM
ISO-FLOW FURNACES

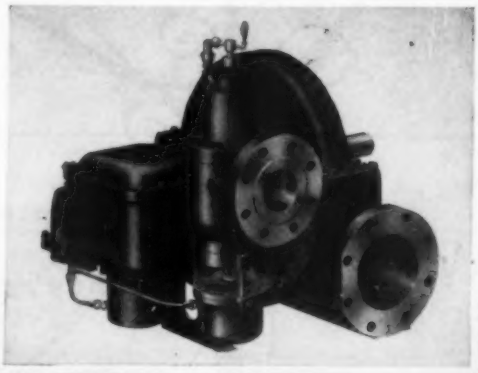
PETRO-CHEM DEVELOPMENT CO., INC.

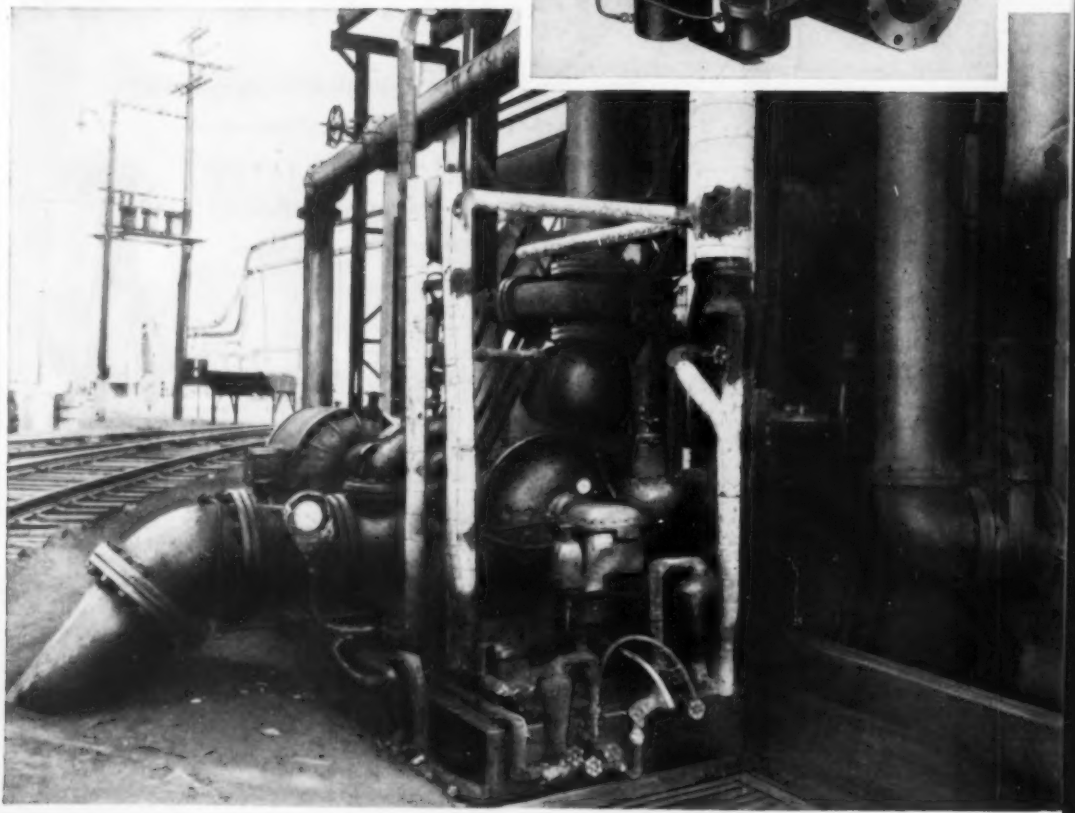
REPRESENTATIVES

in turbine drives

Hydraulic Governing

TYPE DP TURBINES





OUTDOOR INSTALLATIONS, such as this one in an oil refinery, are taken in stride by the DP—another advantage of the totally enclosed, hydraulic governing system. Weather conditions and corrosive atmospheres don't bother the sealed-in unit.

DP means Dependable Power

Means Dependability

No part of a mechanical-drive turbine has more to do with day-to-day dependability than the governor. And in most installations, dependability is something that comes ahead of all other considerations—something you're willing to pay a little more to get.

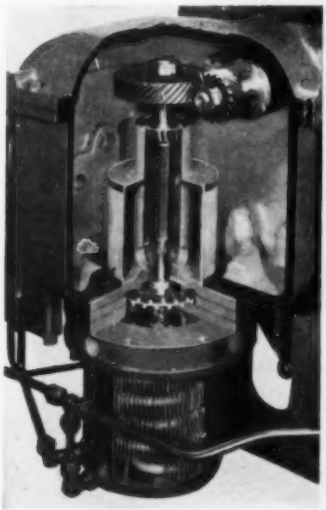
That's why General Electric standardized three years ago on hydraulic governing for its small, mechanical-drive turbines. The Type DP has the same kind of governor that's used with large, utility-type turbines. The operating record of hundreds of DP's in service throughout the country testifies to the soundness of this design.

It eliminates such elements as push rods, thrust bearings, knife-edges, etc., which are subject to wear and maladjustment. The governor operates in a totally enclosed oil atmosphere which protects parts from corrosion and rust.

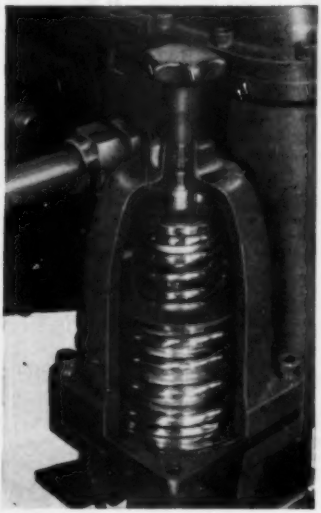
Sometimes, turbines are used as standbys and put in service only at irregular intervals. Hydraulic governing eliminates the possibility of gumming and sticking during long periods of idleness—the DP is ready to go at a moment's notice.

Performance-wise, the DP provides a 30% adjustable speed range—adequate for most applications. If you need more, the Type DR is available with a 5 to 1 speed range. Ask your nearby General Electric sales engineer for complete DP details. *General Electric Company, Schenectady, N. Y.*

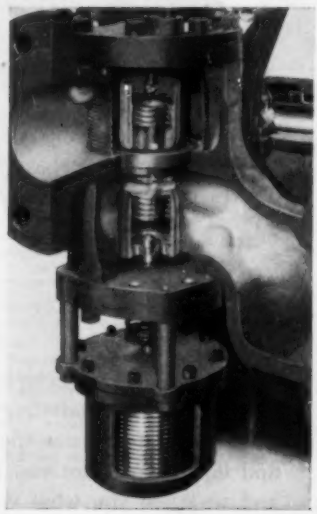
HOW THE DP GOVERNOR OPERATES



This turbine-type oil pump, gear driven from the main shaft, signals any variation in the turbine speed due to changes in load. The pump also provides oil pressure for positioning the governor valve.



Acting on the speed signal from the oil pump, this pressure relay controls the amount of oil pressure in the operating cylinder. The pressure relay operates automatically after being hand set by the operator.



The operating cylinder, controlled by the relay, opens and closes the governing valve, thus regulating the steam admitted to the turbine. This system almost completely eliminates the need for moving parts.

GENERAL ELECTRIC

252-51

WE'LL BREAK YOUR FRACTIONATING "BOTTLENECKS" . . .

AT LEAST 30% ADDITIONAL THRUPUT IS GUARANTEED WITH KOCH "BENTURI"—TYPE KASKADE TRAYS

IN the past few months, Koch Kaskade trays have broken 24 "bottlenecks" in all ranges of bubble tray service—7" to 30" tray space—from 5 mm. absolute to 820 psig. operating pressure—BECAUSE PROGRESSIVE OPERATORS REPLACED CONVENTIONAL BUBBLE TRAYS WITH KOCH KASKADE TRAYS.

Your "bottlenecks" can be broken, too! Write today, advising us of your existing tower size, the vapor and liquid capacities you desire, and we'll tell you what you can obtain with Koch Kaskade trays.

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For Today's Tough Service Demands

EFFICIENT AND DEPENDABLE STEAM GENERATION

Vogt steam generating units are designed to give maximum rating in a minimum of space with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels, as desired, meet every power, heating or process requirement.

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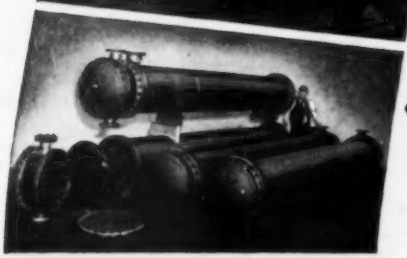
Stills, towers, oil chilling machines, filter presses, heat exchangers, etc. are constructed to all Codes. They meet all demands for operating security and trouble-free performance and help to lower costs in important process industries around the world.

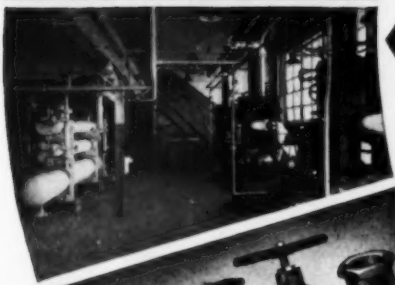


SPECIAL MATERIALS FIGHT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment made from special metals and alloys to combat corrosion, and product contamination or discoloration. Fabrication procedures employed insure that corrosion resistant properties of welds will match that of the materials from which units are constructed.

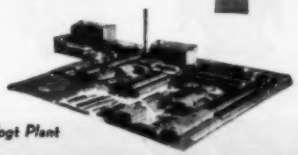
MORE TONNAGE AT LESS COST

Over 60 years of manufacturing experience, engineering and research stand behind Vogt refrigerating and ice making machinery. Absorption Systems, Compression Systems, and the Automatic Tube-Ice Machine in a wide range of capacities serve in leading petroleum refineries, chemical plants, ice and cold storage plants, dairies, packing plants, etc., at home and abroad.



DROP FORGED FOR EXTRA TOUGHNESS AND LONG-TIME SERVICE

Vogt valves, fittings and flanges, for top performance in oil, water, air, gas, and ammonia services, at high or low pressures and temperatures, are available drop forged entirely from carbon steel or stainless steel. Valves can be furnished in a combination of materials by using stainless steel for parts affected by service temperature or corrosion, and less expensive alloys or carbon steel for other parts.



Air View of Vogt Plant

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

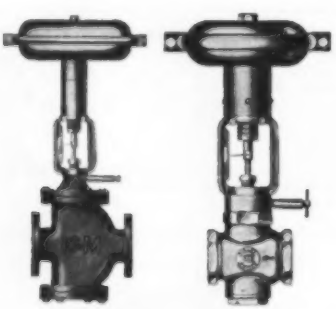
BRANCH OFFICES NEW YORK PHILADELPHIA CLEVELAND CHICAGO ST. LOUIS DALLAS

Why Most Leading Companies Are Using K & M Control Valves

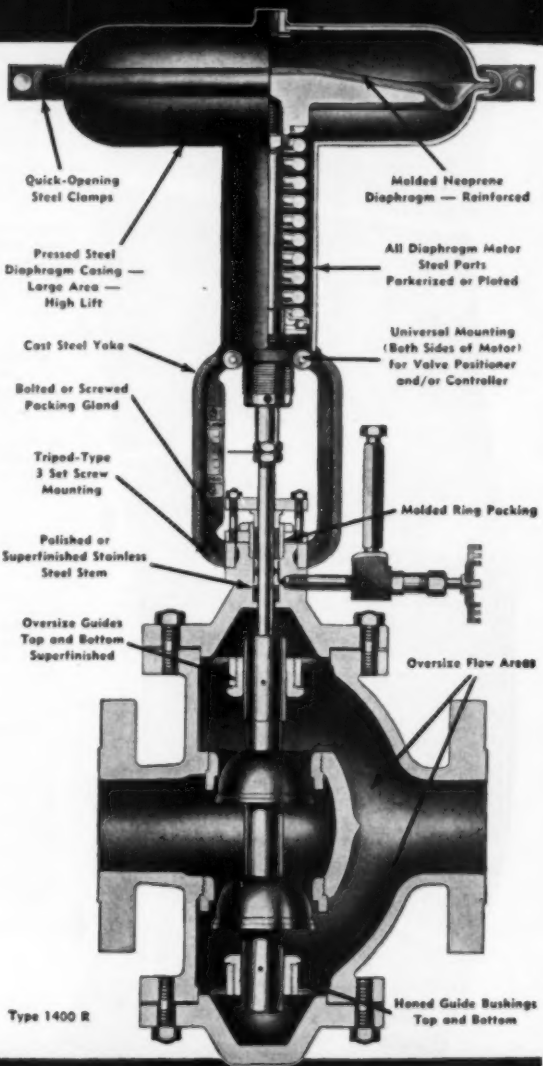
It is logical that leading companies should handle the important subject of control valves as they do other matters: They make use of the best available skills and thinking. More and more, they utilize the equipment, knowledge and facilities of the K & M engineering and service team.

Five years ago, K & M Advanced-Type Control Valves were new to industry. Today, with outstanding performance records behind them, K & M valves have become first in the regard of many instrument engineers. Increasingly, K & M representatives are called upon to give counsel and assistance in the planning of new control installations and the improvement of old ones. During the past year K & M men have been consulted on most of the projects in which control valves have been a major consideration.

There is a qualified K & M representative near you, eager to discuss your problems and able to help you with them.



Type 1200 Type 1000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All Diaphragm Motor Steel Parts Parkerized or Plated
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Valve Makers Since 1879

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CHASE ANTIMONIAL ADMIRALTY

(A patented alloy)

Thousands of installations since 1935 prove that Chase Antimonial Admiralty* adds years of service to heat exchanger life.

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FREE BOOK — Send for the new Chase book discussing problems of corrosion in condenser and heat exchanger tubes, selection of proper alloy, and information on installing tubes. Fill in coupon below.

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NEW BOOK includes Specifications, Weights, Dimensions and other data.

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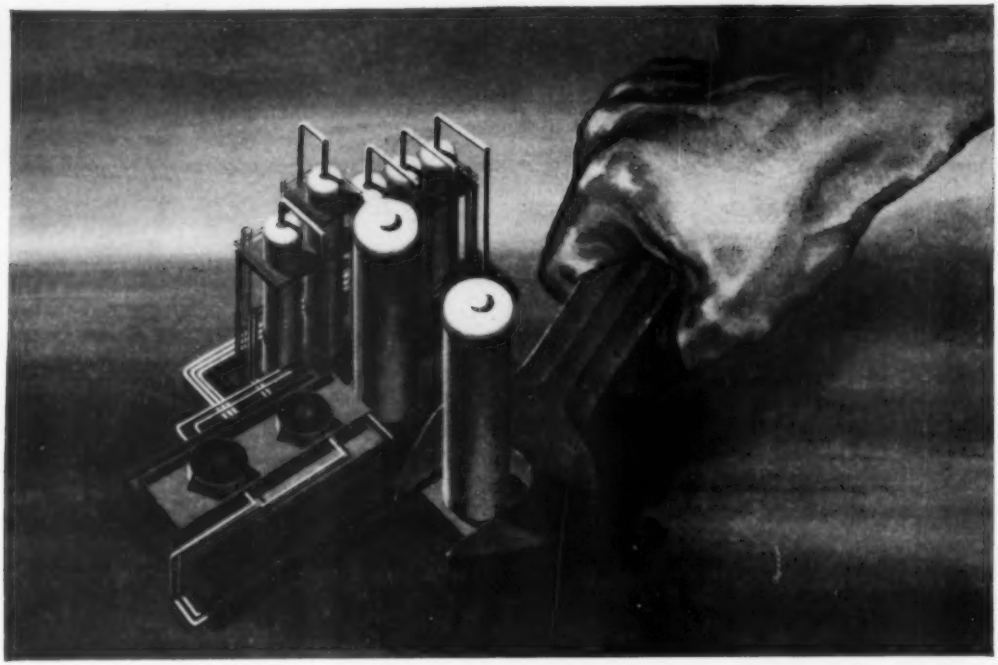

How To Bolt Down Profits In New Production Planning

Has a tough operating problem threatened your output schedules? Here's how one producer licked his problem before it started.

For a new process this refinery required economical heating, under vacuum, of highly corrosive crude that was to be pumped into a fractionator for further processing.

SOLUTION: Crude oil feed tanks of stainless-clad steel, vertical type, externally braced. Heat is provided by an internal steam coil of solid stainless steel. Vacuum operation is withstood successfully by clad steel tank design. Flued openings and manholes provide for easy inspection and maintenance. Inner stainless surfaces resist corrosion; carbon steel backing and steel stiffening rings insure rigidity and strength with maximum economy. Result: economical heating of crude oil to proper temperature. Corrosion problem eliminated by equipment with low first cost and long service life. Maintenance costs reduced to a minimum.

This unit increased this company's output and profits. It was ideal for the job. How was this advance achieved? Through close coordination between engineering staffs of progressive Equipment Builders, process engineers, designers and materials suppliers.

Such bonus attention is a practice with progressive Equipment Builders. They turn to Lukens regularly for its knowledge of materials as well as its wide range of low-cost clad steels.

Would you like such specialists to study your problem? We will send you their names. Write today explaining your need. Manager, Marketing Service, 404 Lukens Building, Coatesville, Pennsylvania.

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the most effective gasoline additives known!

FOR 15 YEARS Tennessee Eastman has manufactured the most effective and efficient gum-inhibiting gasoline additives known to the refining industry.

While the name, TENAMENE, is new to the industry, the products themselves are not. Formerly these inhibitors were sold through another company and under that company's name. Today these additives are available directly from the basic manufacturer.

Whether you have been using these Eastman additives under another name or not, you'll find TENAMENE represents the peak in quality and performance. And more than this, you'll enjoy doing business with Tennessee Eastman.

We will be pleased to send you specifications, prices and samples. Write to Tennessee Eastman Company, Kingsport, Tennessee, or call our nearest sales representative.

WHICH DO YOU NEED?

Tenamene 1

a gum inhibitor for motor fuels →

Specific Gravity, 75°/75°F.	0.89-0.91
Viscosity at 100°F. (Saybolt Universal)	49 secs.
Freezing Point	—27°F.
Flash Point (Tag Closed Cup)	61°F.

Tenamene 2

← *a gum inhibitor for motor fuels and aviation gasolines*

Specific Gravity, 75°/75°F.	0.94-0.95
Viscosity at 100°F. (Saybolt Universal)	63 secs.
Melting Point	>64°F.
Flash Point (Cleveland Open Cup)	285°F.

Tenamene 60

a copper deactivator →

Specific Gravity, 75°/75°F.	1.07
Viscosity at 100°F. (Saybolt Universal)	80 secs.
Freezing Point	—1°F.
Flash Point (Tag Closed Cup)	19°F.

Tenamene EASTMAN GASOLINE ADDITIVES

STOCKS OF TENAMENE are carried in Lodi, New Jersey; Houston; Los Angeles; San Francisco; and Kingsport, Tennessee.

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TENNESSEE EASTMAN COMPANY, *Division of Eastman Kodak Company,* **KINGSPORT, TENNESSEE**

H.P. pipe gaskets like these *made to your order* by gasket specialists...

...to save you both time and money

When you need metallic gaskets for high pressure piping, put the job up to Johns-Manville Goetze Gasket specialists. You benefit in many ways:

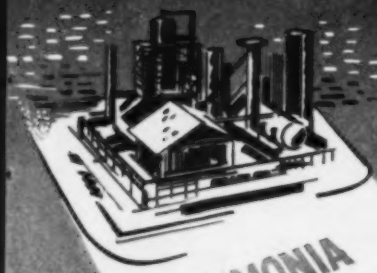
You get the exact gaskets you need for maximum efficiency under *your* operating conditions, tailor-made to fit *your* equipment. You get the savings in cost made possible by intensive specialization and modern production tooling. And you get the full benefit of over sixty years' experience in designing specialized metallic gaskets for industry's most complex sealing requirements.

Typical styles of Johns-Manville Goetze Gaskets that have been made to order for high pressure piping service are shown above. The flare type gasket with bellows action and the solid flare type are particularly suited for pressures above 5000 psi; the profile and V-Tite gaskets are generally used for lower pressures. Each of these is fabricated to extremely close tolerances. Other styles can be made to any desired cross section to meet your individual requirements.

For more information about Johns-Manville Goetze Gaskets, write for your copy of Catalog PK-35A. Or send us your drawing or template for an immediate quotation. Address: Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville *Goetze* GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE



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AMMONIA
HYDROGEN SULFIDE
CHLORINE
SULFURIC ACID
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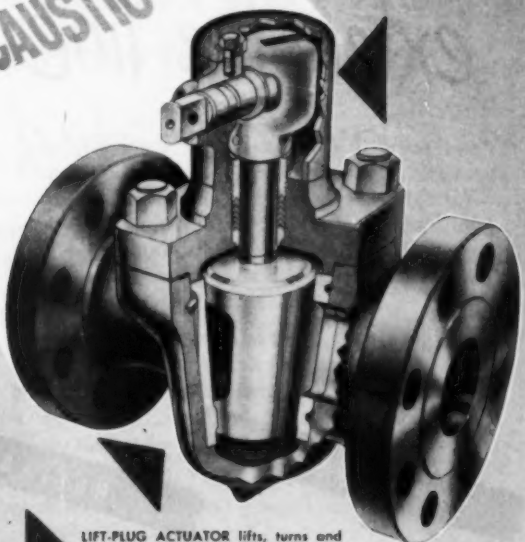
CO_2
HYDROFLUORIC ACID
CAUSTIC

HEADACHE ?

HERE'S A VALVE THAT WILL GIVE YOU RELIEF...



Cameron

NON-LUBRICATED

LIFT-PLUG VALVE

No matter what the service may be, here is a plug valve that is unique in that its seat is separate and not attached to the body and, therefore, can be trimmed in any desired corrosion-resistant alloy. Thus, the seat and plug may be replaced easily and at low cost, should it become necessary, by simply removing the bonnet. The entire operation requires only a few minutes and the valve body remains in the line. Here is, truly, an innovation in special trim valves for special services.

The Cameron Lift-Plug Valve is non-lubricated. Think of the man-hours (and grease) it will save you. This feature also prevents contamination of line products by valve lubricants. There's nothing to clog metering equipment, either.

Let us send you a booklet that tells the complete story of this remarkable valve. Like other plant operators who have purchased these valves for particularly difficult services, you may find them to be the answer to all of your problems, too.

Please write to:

LIFT-PLUG ACTUATOR lifts, turns and reseats plug in only three-quarters of a turn of the operating wrench.

SEPARATE, RENEWABLE SEAT: Pressure-created body deflections and line strains cannot destroy the geometry of the fit between sealing surfaces because they cannot be transmitted to the separate seat.

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sells an extensive line of oxygenated solvents and chemicals

The famous ENJAY* Oval Trade-Mark stands for a diverse line of high-quality solvents and chemicals. Every day more industries are using ENJAY materials to produce improved products.

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ENJAY markets this wide range of industrial chemicals:

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Methyl Ethyl Ketone
Ethyl Ether
Isopropyl Ether
Diisobutylene
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ENJAY products are marketed in bulk or in quantities to fit your requirements.

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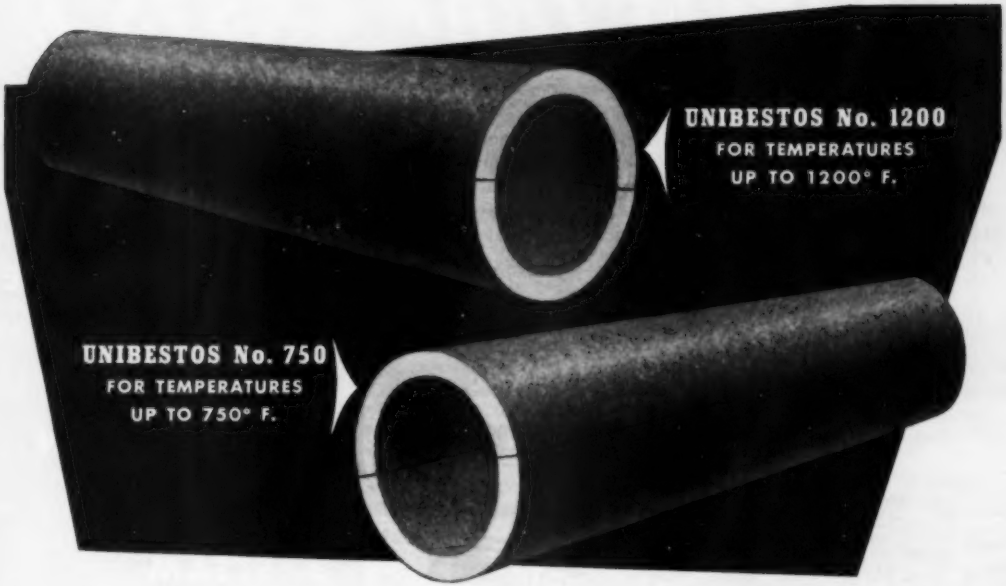

These famous UNIBESTOS twins cut heat loss and surface temperature

HIGH EFFICIENCY IS UNIMPAIRED BY REUSE OR CONTINUOUS SERVICE

When you insulate with Unibestos you can be sure of *prolonged* effectiveness, for this durable African Amosite product resists all service hazards. It's unaffected by moisture, steam, fumes . . . withstands impact and vibration . . . won't shatter, crumble, powder, or dust to contaminate the atmosphere under normal service conditions.

Unibestos is easy to cut and fit . . . brings you the added economy of *single-layer* application . . . may be removed and reused repeatedly without damage or loss of efficiency. Adjacent sections can be stapled together to prevent separation due to expansion.

Phone your Unarco Distributor for *money-saving* Unibestos in cylinders, half-rounds, or blocks.

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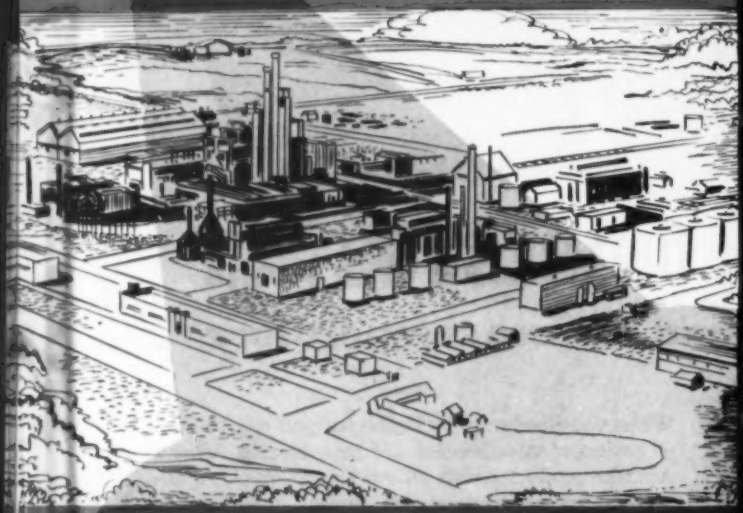
A STEAM TRAP CASTS A

BIG effects from little traps! And, the effects are multiplied by the number of traps in the plant you design or operate until they grow to be a *major* influence upon operating efficiency and economy. Before you specify steam traps ask your nearby Armstrong Representative to call. He is qualified to give you practical assistance and answers that can save you a lot of time and trouble.



THINGS STEAM TRAPS AFFECT

1. HEAT-UP OR START-UP TIME
2. RATE OF PRODUCTION
3. STEAM WASTE
4. FUEL WASTE
5. CONTINUITY OF OPERATION
6. MAINTENANCE COST

Cast semi-steel side outlet — side outlet series, ½", ¾" and 1" pipe connections.

Cast semi-steel bottom outlet — top outlet series, ½", through 2" pipe connections.

Forged steel series for high pressures to 1500 psig and for low and medium pressures where all-steel fittings are desirable.

ARMSTRONG MACHINE WORKS
852 Maple St., Three Rivers, Michigan

It Pays to Specify

ARMSTRONG

MIGHTY BIG SHADOW

REASON	HOW ARMSTRONG TRAPS MEET THE NEED	EXAMPLE
When steam is turned on, large amounts of condensate *and air* must be removed before equipment heats up.	Condensate *and air* removed as fast as they reach trap. Reliable data insures you get trap with adequate safety factor to meet conditions.	*40 Minute Faster Heat-up*—drying oven at pharmaceutical plant heats up 40 minutes sooner with Armstrong "Blast" traps.
Quick heat-up, maximum temperatures essential for maximum output.	Air which reduces temperature and heat transfer discharged automatically; condensate discharged at steam temperature; equipment kept *full* of hot, dry steam.	*30% Greater Output* – jacketed kettles produce 30% more at Canadian plant since changing to Armstrong traps.
When steam gets past traps, boiler capacity may be inadequate—this is bad even if you could afford the fuel waste.	When steam floats the bucket the trap closes. No steam ever reaches discharge orifice, even when there is no condensate load. Heat treated chrome steel valve parts, precision ground and lapped, resist wire drawing and wear, stay leak tight for a long, long time.	*Steam Savings Eliminate Need for New Boiler*—chemical plant shelves plans to buy larger boiler after installing Armstrong Traps.
Why burn fuel to generate steam that does no useful work . . . blows through traps, for example?		*33⅓% Reduction in Fuel Bill* – after trapping vats with Armstrongs at Missouri plant.
When traps are inoperative or down for repairs, unit being drained may be "off the line."	Nothing to clog, seize, stick or collapse! Large orifice. Self-scrubbing action cleans out ordinary dirt and scale. "Frictionless" leverage with wear points heavily reinforced for long life. Hardened chrome steel valve and seat. Wear and corrosion-resistant stainless trim.	*Maintenance Time Cut 30%* – Illinois user says, "Unequalled dependability, simplicity of design means repairs can be made quickly" (with minimum equipment downtime).
Traps that don't "wear well" take a lot of manhours for repair.		*50% Less Trap Maintenance* – only half as many manhours devoted to traps since installing Armstrongs throughout large Midwestern plant.

SEND FOR THE *NEW* ARMSTRONG STEAM TRAP BOOK

Fresh off the press—44 pages of practical trapping data. Tells how to select traps for nearly every class of equipment; explains safety factors; gives prices, physical data, service pressure ratings of Armstrong traps; includes recommended installation, maintenance and trouble-shooting practice; contains many time-saving charts and tables—condensing rates, trap capacities, trap size recommendations and others. For your free copy, call your local Armstrong Representative or write to Armstrong.

STEAM TRAPS

Is there a gas we haven't met?

Our Carrier Centrifugal Compressors have compressed more different gases on the job than those of any other manufacturer. We think experience like that is important to you.

Maybe you work with butane or propane. Ethylene, methylene chloride, ethane or chlorine. Air, oxygen, sulphur dioxide or hydrogen sulphide. All of these and many more have been used in our Centrifugal Compressors at some time or other during the past thirty years. So there's a lot of experience for you to draw upon when you call on Carrier.

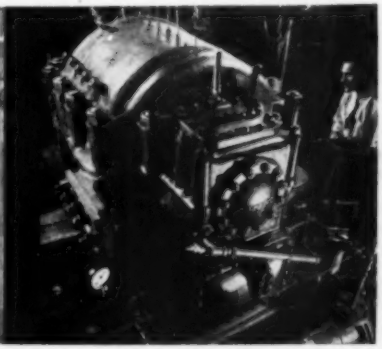
Carrier Centrifugal Compressors are available in standard designs from 2000 to 40,000 cfm, with three to seven wheels. In most cases they need no individual engineering. And they're built from standard, pretested components — you're sure of good performance right from the start.

There's a lot more to our Centrifugal Compressor story, of course. Why not consult the Carrier office nearest you? Or write Carrier Corporation, Syracuse 1, New York, for the catalog, "Centrifugal Compressors for Industry."

Carrier

CENTRIFUGAL COMPRESSORS

REFRIGERATING EQUIPMENT



Carrier has built more multi-stage Centrifugal Compressors than any other manufacturer. Here is one of them (left) on the job at a petroleum company. Skilled workmanship, precision inspections (right) and grueling tests make Carrier Centrifugal Compressors the most dependable you can buy.

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Processing 65 Million Cubic Feet of Gas Per Day In the *Dollarhide Field*

This plant, the most recent of the more than 100 major projects completed by HUDSON, processes all the gas produced in the Dollarhide oil field of Andrews County in West Texas. The gas is compressed to 650 pounds per square inch and treated to remove Hydrogen Sulphide, after which about half of the gas is used for gas lift, and half processed for removal of at least 75% of the propane and essentially 100% of the butanes and natural gasoline.

The plant was designed and constructed by HUDSON in collaboration with engineers of The Pure Oil Company.

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Duplex Receiver Duragauge—3½" Dial Size. Peripheral pointer is red.

Compact panelboard design demands pressure gauges that combine extreme accuracy with smaller size, easy-to-read dials. *The new Ashcroft Receiver Duragauges, with 3½" dial, meet those requirements exactly.*

Wherever pneumatic transmission and control systems are used to indicate pressure, temperature or flow—in power plants, refineries, chemical plants—these new *Receiver* Duragauges provide *accuracy within ½ of 1 percent of the dial range.* Standard transmitted air pressure range is 3 to 15 P. S. I. Other ranges include 2 to 14, 2 to 15, 3 to 18 and 5 to 25 P. S. I.

Single and Duplex *Receiver* Duragauges are available. The Duplex incorporates two separate sets of Bourdon tubes, movements and pointers. Bourdon tube material is heat-treated phosphor bronze, extra wide for extreme sensitivity, with long tip travel for precision accuracy.

Get complete data, including dimensions and standard graduations. Your Ashcroft Distributor will gladly help you select the right *Receiver* Duragauges for your specific needs.

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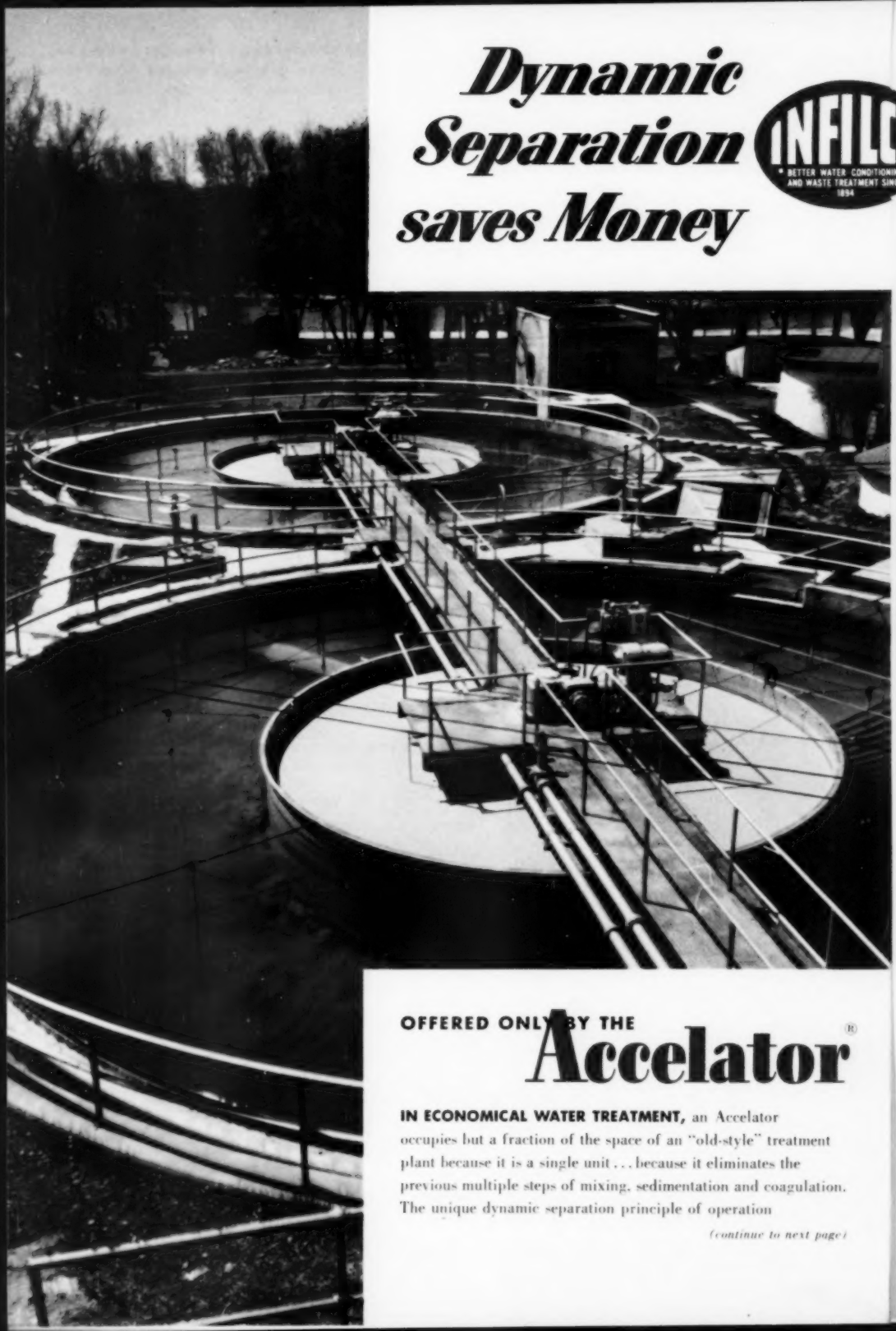
Dynamic Separation saves Money

INFILCO
* BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1934 *



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IN ECONOMICAL WATER TREATMENT, an Accelator occupies but a fraction of the space of an "old-style" treatment plant because it is a single unit . . . because it eliminates the previous multiple steps of mixing, sedimentation and coagulation. The unique dynamic separation principle of operation

(continue to next page)

(from preceding page)

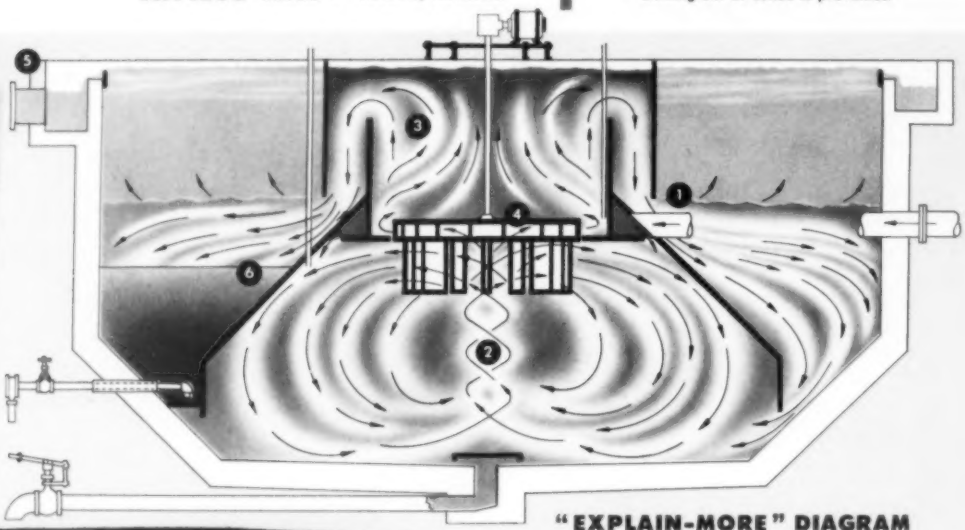
INFILCO
* BETTER WATER CONDITIONING * AND WASTE TREATMENT SINCE 1934

permits the treated water to separate from the top of a downward-moving pool of uniformly sized slurry in contrast to having the treated water filter upward through a suspension of sludge of gradually decreasing particle sizes.

INFILCO INC. ★ *Tucson, Arizona*

Outstanding advantages—based on more than two thousand Accelator efficiency-of-operation reports:

- ★ Faster separation of solids from treated water
- ★ Low-velocity movement of tremendous quantities prevents floc break-up
- ★ Rapid mixing of incoming water and chemically impregnated slurry
- ★ Small or large flows have complete contact with slurry
- ★ Thickened sludge is automatically drawn off
- ★ Settling-out of solids is prevented

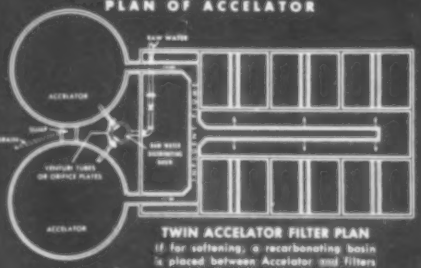


"EXPLAIN-MORE" DIAGRAM

the Accelator basin contains:

1. A raw water inlet and distributing duct
2. A primary mixing and reaction zone
3. Two concentric draft tubes which form the secondary mixing and reaction zone
4. A rotor-impeller for mixing and pumping, driven by a motorized reducer
5. An effluent launder system
6. Concentrators to accumulate and remove excess slurry

PLAN OF ACCELATOR



TWIN ACCELATOR FILTER PLAN
If for softening, a recarbonating basin is placed between Accelator and filters

TYPICAL ACCELATOR LAYOUT

SUGGESTED ACCELATOR APPLICATIONS / POSSIBLE TREATMENT REQUIREMENTS → / WATER END-USE	SOFTENING	CLARIFICATION	STABILIZATION	ALKALINITY REDUCTION	ORGANIC MATTER REMOVAL	TASTE AND ODOR REMOVAL	COLOR REMOVAL	IRON REMOVAL	SILICA REDUCTION	NEUTRALIZATION
MUNICIPAL	X	X		X	X	X	X	X		
PULP	X	X		X	X		X	X		
PAPER	X	X		X	X		X	X		
BEVERAGES		X		X	X	X	X	X		
COOLANT	X	X	X	X	X			X		
BOILER FEED	X	X		X	X		X	X	X	
RAILROADS	X	X					X			
TEXTILE	X	X			X		X	X		
CANNERIES		X		X	X	X		X		
BREWERIES		X		X	X	X	X	X		
OIL FIELD FLOODING		X	X		X		X	X		
BRINE DISPOSAL		X	X		X		X	X		
INDUSTRIAL WASTES DISPOSAL AND REFUSE		X	X		X		X			X

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designed specifically for cooling tower fans

Geareducers are designed and built by Marley to do just one job—drive fans up to 264 inches in diameter—and do it better than any other mechanism. Years of research and field service prove Geareducer design provides everything needed to resist thrust set up by huge fans. This includes oversize taper roller bearings; hardened alloy steel gears of scientifically selected ratio; pumpless, continuous splash lubrication, super-strong shafts and cases. Every detail of the design has a specific purpose: consider the wide-spread feet for great stability and the magnetic drain plug that retains any loose particles of metal that might cause wear.

In production all machine processes are constantly inspected with exacting care. When completed, every Geareducer is run in, disassembled, carefully checked part by part, completely coated with moisture resistant grease, and reassembled for shipment.

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DRICOOLERS
AQUATOWERS
NATURAL DRAFT TOWERS
CONVENTIONAL TOWERS
SPRAY NOZZLES
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DOUBLE FLOW AQUATOWERS

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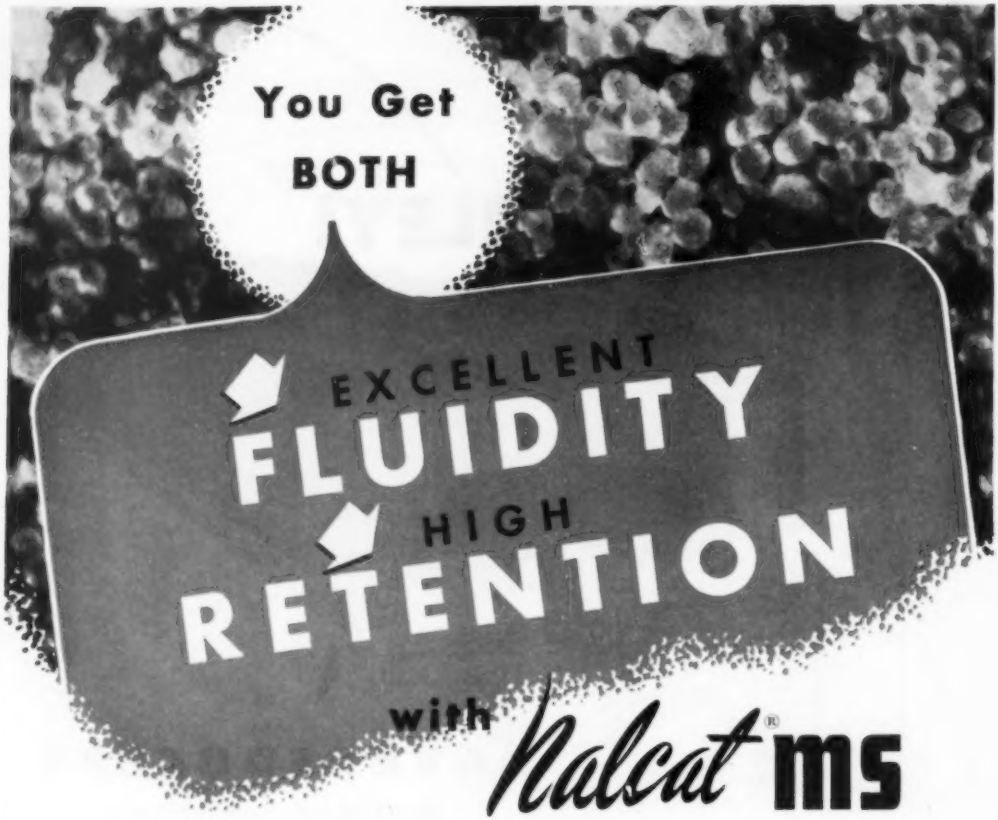

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You get excellent fluidity, with low losses of Nalcat MS Catalyst because of controlled particle size distribution. This, plus high resistance to attrition and high activity, gives you maximum catalyst efficiency and economy.

Write, now, for data on Nalcat MS Catalyst for use in your catalytic cracking unit.

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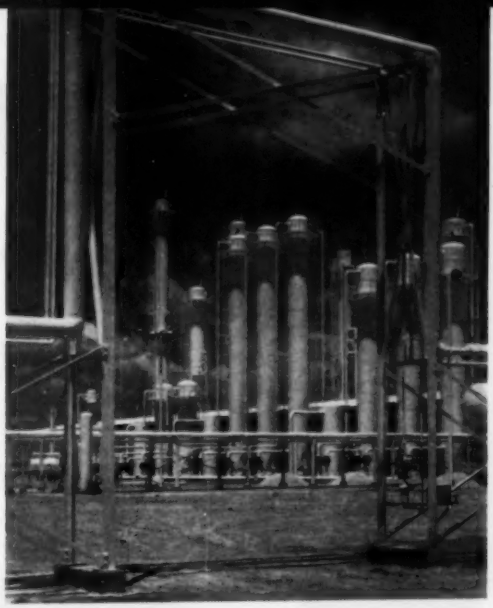
PETROLEUM REFINER

The LOOK BOX



Right vs. Politics

ANOTHER MOVE has been made, this time by Representative Mason (R., Ill.) to put an end to the inequitable tax privileges enjoyed by the nation's cooperatives. Congressman Mason calls it "the archaic privileges of cooperatives operating in direct competition with fully-taxed privately operated petroleum distributors." The congressman pulls no punches, either, when he says that his effort will be to require "these tax dodgers . . . to pay the full corporate income tax on all their earnings."

Remember when the administration referred to the oil industry's depletion allowance as a "loophole"? Well, here's a real loophole, Mr. President. Political considerations heretofore have blinded those in power against taking the right action—the removal of this privilege. But one day a congressional majority will see the light and put an end to such governmental favoritism. And if they have the courage to take action during the current session, they can, according to Representative Mason, raise through this source, which would be "new revenue," one-fifth of the amount of increase which Truman asked for in his recent economic message.

Here are some of the citations against co-ops, as listed by the gentleman from Illinois:

> "During 1950, about 2230 local co-ops supplied a million farms with more than 1,400,000,000 gallons of fuel—about 16 percent of total liquid petroleum fuels used on farms; 20 percent of fuel consumed by farmers in areas where co-ops operated; and 2.25 percent of total domestic consumption of refined fuels in the U. S.
>
> "In Illinois, petroleum sales to farms by tax-exempt or tax-favored co-ops were approximately 65 percent of sales by fully taxed and privately owned concerns.
>
> "Consumers Cooperative Association of Kansas City, 'largest of the co-operatives specializing in petroleum products,' at 1951 annual meeting announced expansion plans to increase petroleum sales by 23 percent with over-all sales goal of $100 million annually by 1953."

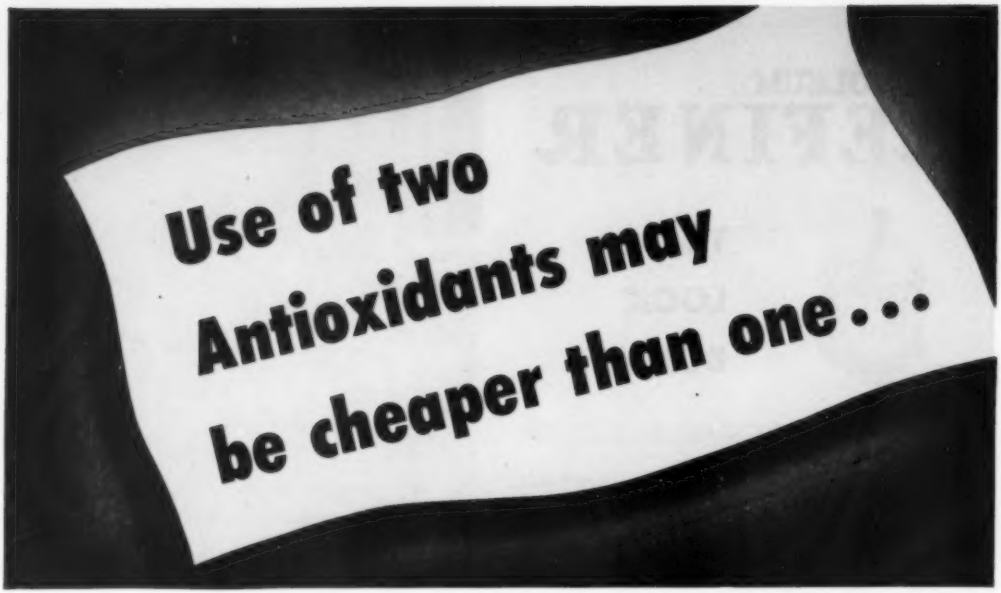
The need for action is acute. Maybe congressional backbones would be strengthened if business men and industry would speak their piece—and pointedly. There is nothing fair, nothing American, about such a concession enjoyed by one segment of our population at the direct expense of all other fax payers.

Steel for Refinery Expansion

ADDITIONAL steel to spur construction of needed refining capacity may be a possibility later in 1952, based on a recent Petroleum Administration for Defense statement that the agency is developing a new refinery expansion program designed to permit construction of 475,000 barrels daily of new refining capacity annually. Such an increase would be nearly 44 percent higher than PAD's present steel allocation program for the refining branch, which on paper calls for 330,000 barrels daily per year of new capacity.

The present program, which is not being fully achieved because of material shortages, was reduced from PAD's original plans to request steel for the construction of 500,000 barrels daily of new capacity annually in 1951 and 1952 to allow the build-up of reserve capacity ultimately aimed at one million barrels daily in the refining, production and transportation branches of the industry. Such an increase in reserve petroleum industry capacity was requested by the military at the out-

Interesting View of the Processing Area, Framed by a Gateway of Overhead Pipe, Plymouth Oil Company's Gas Processing Plant in the Benedum Field, Upton County, Texas. (Photo—at top of page—by Bill Thompson.)



Du Pont District Laboratories may save you money by recommending combinations of antioxidants for certain gasoline stocks

Antioxidant treating results vary with different gasolines. Recognizing this, Du Pont makes two types of antioxidants—Nos. 5 and 22. The question then arises, which is most effective in your particular stocks—depending on your current induction period specifications. Or, might a combination of the two work out best? For an answer to such queries, the nearest Du Pont Petroleum Chemicals Division district laboratory will be glad to evaluate your stocks for antioxidant response. Here is the result of one such investigation . . .

One refiner's gasoline responded more favorably to Du Pont Antioxidant No. 5. Nevertheless, due to an abnormal caustic carry-over in the treating process, Du Pont Antioxidant No. 22 was considered mandatory in this case.

After studying this refiner's treating process and gasoline stocks, the Du Pont district laboratory recommended as a first step that 2 lbs. of Antioxidant No. 22 per 1000 barrels be added as the cracked stream left the cracking unit. This served to protect the stocks prior to and during sweetening.

After doctor treating, the gasoline was further inhibited to a 360 minute induction period with Du Pont Antioxidant No. 5 during the final blending process... *A six-month trial period showed that this method provided a substantial saving for the refiner.*

If you have any antioxidant treating problems, if you have recently changed stocks, or, if you have merely changed your induction period level, the nearest Du Pont district laboratory will be glad to help you determine the most effective means of using antioxidants.

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break of the Korean conflict to provide necessary petroleum for any emergency that might arise. Petroleum had an over-all down-the-line reserve capacity of one million barrels daily at the start of World War II, which amounted to 25 percent above actual demand at that time.

While refining capacity during 1951 was increased by an estimated 266,400 barrels daily, increased demand for petroleum last year, part of which resulted from the Iranian close-down, wiped out more than 400,000 barrels daily of reserve capacity that had existed at the start of the year. Best estimates indicate that no more than 300,000 barrels daily of additional capacity will be constructed this year, due entirely to materials availability, and if present forecasts of demand are realized, refinery operations this year will have to be scheduled at an average of 91.8 percent of capacity in the first half and 93.5 percent in the final months of the year. Operations last year averaged about 90 percent of capacity.

No sizeable increase in refinery construction has been reflected in PAD allocations of steel for the first half of 1952. Second quarter allotments of steel to the refining branch total 158,472 tons of carbon, alloy and stainless steel, an increase of 33,300 tons over the first quarter allocations, but 8,300 tons less than was permitted in the final three months of 1951 when the Controlled Materials Plan was first started. Allocations of copper for the refining branch of 3.8 million pounds for the second quarter, however, will be more than double the amount permitted to be used in each of the previous two quarters and the allocation of aluminum will be 50,000 pounds higher at 209,000 pounds.

What Happens After Retirement?

THE OIL INDUSTRY is well known for its active promotion of insurance and retirement annuity programs for its employes. In most companies pension plans are offered which lay the foundation for financial security of the employe upon retirement, usually at age 65. But what happens to these people after retirement? How many of them successfully meet the adjustment of retired life? How many of them know how to use retirement to fullest advantage?

These are questions which increasing numbers of thoughtful oil company executives are giving consideration. We note with particular interest the announcement that Esso Standard Oil Company has inaugurated a program for helping their older employes prepare for retirement. After studying the problem of retirement and considering their own large group of annuitants, Esso decided that they might be able to help their employes prepare for retirement.

The program as set out by Esso is purely voluntary, and is based on a series of group sessions attended by employes who are approaching retirement. Each meeting held is in the nature of a discussion—informal, and of a serious "bull session" type. It is expected that the stimulation of thought, and exchange of ideas thus promoted should make a contribution to successful retirement.

Is Bigness A Menace?

AS A SCAPEGOAT for economic ills, big business has suffered to the point that "bigness in industry" and "evil" have become synonymous in the minds of the public. In answer to the question "Is bigness in itself a menace?" Dr. Robert E. Wilson, chairman of the board, Standard Oil Company (Indiana), has pointed out the fallacy in such an attitude. A portion of his speech, "Is Big Business Bad?—Fact vs. Fiction," is quoted below:

"If bigness in itself is bad, the petroleum industry must plead guilty to the charge. But, given the total size of the industry, which is of course determined by public demand for its service, and the way in which it must be organized to be reasonably efficient, 'bigness' is a necessity. It takes enormous amounts of capital to provide for the discovery and production of crude oil, the transportation and processing of that crude, and the transportation and marketing of finished petroleum products. A single pipe line now proposed to extend only 780 miles involves an investment of $100 million. The total length of crude and product trunk lines in this country as of January 1, 1950, was approximately 92,000 miles. A single ocean tanker may cost over $6 million. There are over 550 tankers owned in the United States. A refinery large enough to be reasonably efficient, running about 30,000 barrels of crude per day and making the usual products, now costs about $40 million. Maximum efficiency and minimum costs require throughputs several times this, and as a result several refineries have been gradually built up to handle over 200,000 barrels per day—but even such refineries are small compared with total United States refinery capacity of over seven million barrels per day.

"Also, further economies may be achieved when a company operates more than one refinery in different areas. In addition, for the most efficient operation it is essential that refineries be served by highly specialized pipe lines and other facilities for the transportation of crude oil and finished products.

"The result is that companies which do less than one percent of the total producing or refining business of the country nevertheless have total assets running into the hundreds of millions of dollars. They are large companies; but it does not follow that because they are big, they are bad.

"What basis is there for the insinuation that our large firms, merely because of their size, are causing harm to our economy?"

The Vulcan organization in Cincinnati has been serving the process industries over the past half century. In 1952 American industry will be called upon to bolster the country's defenses while meeting a steady load of essential civilian demands. In fulfilling these responsibilities, Vulcan is available with its technically-trained staff and specialized facilities to help solve many difficult processing problems.

VULCAN ENGINEERING DIVISION OFFERS:

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A few of the specialized fields in which Vulcan process engineering services have been utilized include:

- Organic chemicals
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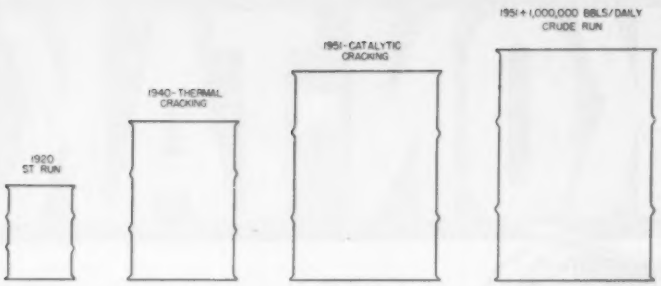

Figure 1. Growth of Petroleum Fuels Through Three Refinery Processing Eras—U.S.A. Production. (Note: Total Fuels Only. Lubricating Oils, Asphalt, Process Products, and the Like Not Included.)

How Engineering Developments Affect Petroleum Fuel Volume and Quality

W. S. MOUNT

Gasoline & Fuel Oil Department,
Socony-Vacuum Oil Company, Inc.

THE OIL INDUSTRY is rapidly reaching the point where further quality increases mean a loss in the percentage of quality gasoline available to the public.

Available quality gasoline blending stocks can be used most effectively if divided between the two gasoline grades to give a quality difference of about nine octane numbers.

The nation's accelerated military program to meet increased jet fuel demand won't help gasoline quality whereas World War II construction to produce aviation gasoline contributed the equivalent of five octane numbers to improvement of motor gasoline.

These are some of the observations in the accompanying discussion of how America's current "guns and butter" economy is making engineers figure out more efficient ways to utilize available supplies of automotive gasoline. Original presentation was at the sectional meeting of the Society of Automotive Engineers held in Los Angeles in December.

IN THIS country today we are trying to absorb the added load of a huge defense program while expanding civilian production at a record pace. This is a challenge to everyone connected with business, but especially to the engineer because he is largely responsible for finding ways to make the best use of what we have. In meeting the challenge, the engineer has a great opportunity not only to do a technical job, but also to win greater recognition of the engineering aspects of the problems we as a nation face in our effort to have both guns and butter.

The normal excess refinery capacity for handling surges in volume demand has been reduced and we are running pretty close to capacity. There is a limit to what we can do to increase quality without expensive additions to equipment, and such additions in the near future are likely to win approval only if they serve a military purpose. Under these conditions, it becomes vital that we get the most efficient use out of the existing quantity and quality of available petroleum fuels.

A critical view of fuel utilization uncovers some opportunity for improvement. Herein will be made an engineer's analysis of the present conditions surrounding the consumption of petroleum fuels and a study will be offered of the possibilities for more efficient fuel utilization using motor gasoline as an example.

It is important in such an analysis to consider basic refinery processing trends and to give attention to long-term trends rather than sharp fluctuations, because it takes time to modify conditions under which fuels are marketed and consumed. It also takes time to influence customer preferences and buying habits. And, most important, any change must be considered in relation to refinery economics, always trying to assure the consumer of a continuing gain over a period of years.

Refining a Variety of Products From Same Barrel of Crude Presents Unusual Problems When Historical Balances Between Products Are Upset

A fundamental problem in the oil industry is refining a variety of products from a single raw material. No refinery process can be altered for one product without affecting several other products. In peacetime new refinery processing equipment can be built to help meet new demands. Under pressure of a growing defense effort, however, new construction for special civilian purposes is curtailed and the shocks of changes in demand for one major product are felt in all others.

Short term trends are always better understood if viewed in relation to trends over long periods. The oil industry is now attempting to add a million barrels daily to crude run capacity. Figure 1 shows this increase in relation to refining capacity growth since 1920. The sizes of the barrels for four separate refining periods reflect the growth of petroleum fuels' refinery manufacture. One million barrels daily is not much less than the entire U. S. crude run in 1920. In addition to the cost and technological implications of this tremendous growth, some of the current problems are these:

Steel and strategic metals must be allocated by the Petroleum Administration for Defense largely for aviation gasoline and jet fuels. In the last war, before the coming of the jet engine and when aircraft piston engines called for expansion of refinery units which could produce high octane numbers, the motor fuels were eventually benefited. New aviation gasoline processing units were put to work at war's end for motor gasoline. The switch-over was relatively simple.

Jet engines, however, like low octane numbers. The more they dominate the aircraft field in replacement of piston engines, the less the aviation fuels pro-

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gram contributes to automotive engine progress.

The extent to which new construction for aviation gasoline during World War II helped raise the quality of motor gasoline has been generally underestimated. When the war ended in 1945, the quality contribution made by alkylation and catalytic cracking was absorbed not only in higher octane numbers but in increased volume of premium motor fuel. Figure 2 shows how the immediate postwar percentage of premium stood at 40 percent of the 2 million barrels per day of gasoline compared with 11 percent of the 1.7 million barrels per day immediately prewar. The change in premium sales is represented by the solid line indicating a substantially higher premium sales postwar as compared to prewar. The dotted line shows the fall off in unbranded gasoline sales which, simply for convenience, have all been grouped under the general heading of third grade.

Octane number, while not the only measure of gasoline quality, is important. A comparison of Research* Method octane numbers helps to show the quality gain between 1940 and 1946 when wartime high octane processes were switched over to automotive gasoline. The average for regular grade gasoline in the U. S. was 79.5 in 1940 and 82 in 1946. The average for premium was 85.5 in 1940 and 90 in 1946. When due weight is given to the larger volume of premium sales postwar the gain amounts to the equivalent of five octane numbers.

A further calculation is made to see how much higher our premium grade quality might have been elevated if we had returned to the prewar 11 percent premium volume instead of 40 percent. Theoretically, premium octane number could have been elevated to over 100 octane number. Reaching this level in actual practice might have been difficult, but the point remains that expansion around aviation octane number demands gave motor gasoline a big lift in quality at the end of World War II. Expansion of refineries to fuel the jet engine will make no such contribution to automotive progress.

Influence of Increased Cracking

Fuels today are made from three basic stocks—straight run, thermally cracked and catalytically cracked. Petroleum expansion has developed through three stages, as shown in Figures 3, 4 and 5. These figures again reflect the growth in total volume of fuels manufactured in domestic refineries. The shaded areas marked by vertical lines indicate approximately how much of the total barrel is represented by the cracked products. The purpose is to show products

* All motor gasoline octane numbers in this paper are by Research Method.

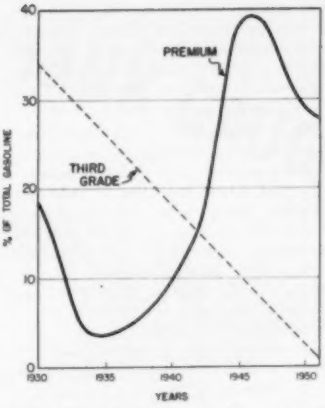

Figure 2. Trend of Premium and Third Grade Sales—Total U. S. A.

more and more highly cracked towards the right and straight run towards the left. The light products are naturally toward the top of the barrel and the heavy products at the bottom.

The year 1920 was selected for Figure 3 because it represents operation toward the end of the straight-run era and before thermal cracking was much of a factor. Straight-run distillation produced virtually all the fuels. Kerosine was still a very large part of production, averaging 12 percent of the crude run, motor gasoline was only 26 percent, middle distillate only 8 percent and residual the astoundingly high figure of 40 percent. The yields are way out of balance with modern needs and much too high a share of the products was sold at the by-product low price rate of residual fuel oils.

The year 1940 is shown (Figure 4) because it marks about the maximum development of thermal cracking and came just before catalytic cracking had made much of an imprint on the industry. Largely due to thermal cracking we increased gasoline yield from 26 percent to 42 percent, and made distillates out of a part of residuals so as to reduce them from 40 percent to 25 percent of products available. In 1940 the demand for middle-of-the-barrel distillates was beginning to catch up with the supply. Distillates were beginning to leave the by-product category which they had shared with residuals. Demands of the diesel, household burner, and the use of the middle-of-the-barrel as charge stocks to catalytic crackers all combined to develop middle distillates as primary products along with gasoline.

The year 1951 (Figure 5) is in the midst of a catalytic processing era. Middle distillates have expanded more rapidly than gasoline, and residuals continue downward. As one million barrels per day crude run are added to 1951 capacity, residuals will drop well below 20 percent and distillates continue to rise.

From a utilization standpoint it is important to note that the distillates, particularly diesel and household heating fuels, having risen out of the by-product to primary product status, have a higher value approaching that of gasoline, and their price now reflects the increased demand. The higher value is a good reason for more efficient utilization.

New refinery processes seldom completely replace old ones. They usually add capacity, leaving older processes for their effective specialized purposes. So it is that we still have straight-run distillation and thermally cracked as well as catalytic stocks. All three types of stocks are needed to balance refinery operations against varying quality demands. The cracking trend is gradually eliminating the straight run, and, as seen in Figures 3, 4, 5 and 6, is changing the character of fuels and calling on us for changes in fuel utilization if we are to make best use of the Btu's which they contain.

Two long term effects are increasingly evident and are closely related to our utilization problems. Additional motor gasoline octane numbers are rapidly becoming more expensive. Fuel oils and diesel fuels are harder to burn and less stable chemically to the extent that they contain cracked stocks.

Having reviewed the general growth in demand for each type of fuel and its cracked character, we now examine some of the effects of these developments as they are related to the present consumer of petroleum fuels.

Shortage of Metallic Lead

From time to time in the past, many have believed that new cracking processes would decrease the importance of tetraethyl lead as a quality component of motor gasoline. Each new surge of catalytic processing has, in fact, reduced TEL needs for a short while. However, the rising cost of refinery construction compared with the relatively firm price of tetraethyl lead have made its use more and more economical and the trend is toward higher concentrations.

The economics are actually so much in favor of tetraethyl lead that automotive engineers, after studying the figures, would probably conclude that, in the interest of real economy to the motorist, the design of engines and the nature of service and maintenance should be planned on the basis of 2 to 3 cc. of TEL per gallon.

In the winter of 1950-51, the oil industry reached an average use of 1.9 cc. TEL per gallon on regular and 2.4 cc. TEL per gallon on premium fuels. Then the government lead stockpiling program was ordered and TEL consumption was reduced 15 to 20 percent, cutting

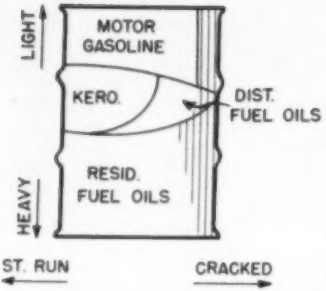

Figure 3. Inside the Petroleum Barrel 1920 (Note: Total Fuels = 86 Percent, Remainder 14 Percent Not Shown.)

octane numbers upwards of one-half unit.

It is apparent that despite increased catalytic cracking both in operation and planned, tetraethyl lead will continue to be essential to the manufacture of quality gasoline. Allocation of tetraethyl lead by the government seems likely to continue for some time. Therefore, the present leveling off in octane numbers may be of considerable duration.

Effect of Jet Fuel Program

Military aviation needs for Grades 100/130 and 115/145 gasoline have diverted the industry's highest octane number stocks away from motor gasoline. The charts in Figures 5 and 6 show a substantial build-up of aviation gasoline, accomplished by diverting aviation alkylate, aromatics, high octane straight-run and catalytic stocks from motor gasoline into aviation gasoline. Increasing concentration of tetraethyl lead in aviation gasoline because of the Iranian oil crisis was a further diversion of quality.

While tetraethyl lead was available in normal amounts, the diversion of high-octane stocks could be offset by using tetraethyl lead in higher concentrations, but government stockpiling of TEL halted that practice. Piston aircraft will continue to take abnormal amounts of high-octane gasoline for some years to come and only a reduction in the tempo of military activity can return high quality components to automotive consumption.

With jet fuels, as noted before, the lower the octane number the better. The oil industry and the military technicians cooperatively have developed jet fuels which are available from low cost, high volume petroleum stocks. Military demand in this field, instead of competing for other high octane number gasolines, is actually using up certain low quality stocks which otherwise would require expensive processing to be marketable. The effect is shown in Figures 5 and 6. While the jet fuels do help motor gasoline quality, the total volume of jet fuel is thus far insufficient to have a significant influence in this direction. To make quality progress, many oil refiners have undertaken expensive reforming of the heavy low-octane gasoline fractions.

Light fractions for jet fuels come from the gasoline range but heavy fractions at present must come from kerosine and diesel fuel. The inroads into kerosine are probably not too serious, because liquefied petroleum gas seems to be taking over much of the cooking and heating load in its place. The removal of light fractions from diesel fuel, however, may be a more serious matter if jet fuels reach a high volume. Their removal from any distillate stock will cause a rise in the pour point which will create cold weather pumpability problems. A loss of combustion cleanliness may develop on diesels along with some domestic oil burner ignition troubles.

In two ways the increasing trend toward cracking is reducing the amount of straight run distillates available to the consumer:

1) Cracking for gasoline produces a *cracked* distillate.

2) Catalytic cracking units, when charged with a distillate, require straight run distillate.

The effects of these two factors are demonstrated in Figures 4, 5 and 6 where virtually all the straight run has already been lost from distillate fuel oils. Catalytically cracked stocks are even finding their way into certain automotive diesel fuels.

Combustion characteristics of domestic oil burners fortunately are relatively unaffected by cracked fuel oils. To the extent that a few burners are affected, proper installation and adjustment provide good results on even the most intensively cracked fuels. The problem that arose with their use lay in the reduced stability of such oils. Darkening of color and formation of tarry sediments became problems, as did the clogging of filters and screens.

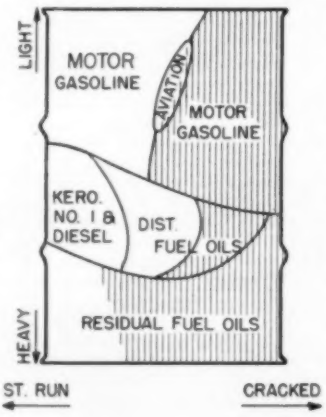

Figure 4. Inside the Petroleum Barrel 1940. (Note: Total Fuels = 87.9 Percent, Remainder 12.1 Percent Not Shown.)

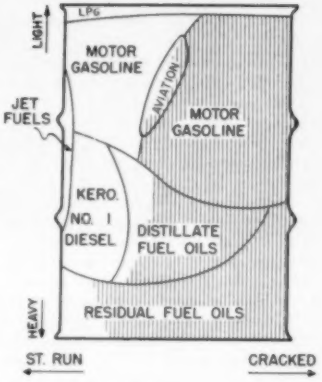

Figure 5. Inside the Petroleum Barrel 1951. (Note: Total Fuels = 89.5 Percent, Remainder 10.5 Percent Not Shown.)

Effective remedies have been developed, however, in refinery treating or in the form of chemical additives which are now moving from the field of lubricants to fuel oils in the form of inhibitors, dispersants and rust preventatives. These additives have no measurable bearing on costs, but they must be watched for their effect on diesels. They have a tendency to pick up and carry along sediment already accumulated in tanks, pumps and so on, so that extra precautions must be taken to avoid the transfer of the sediment from handling systems to the injection equipment.

Diesel engines are generally more quality sensitive than oil burners. Problems have arisen, therefore, when the highly cracked fuel oils have been tried initially in the more critical types of diesel engines. The railroads have probably given the general run of No. 2 and No. 3 fuel oil the most extensive trial in diesel engines. Compared to branded diesel fuels, they have found the fuel oils less uniform in characteristics, not so free from sediment, and dirtier in combustion characteristics. The railroads are learning how to minimize these troubles and capitalize on their lower cost, so it is quite possible that the cracking trend will not affect them much.

Enough on the general trend of fuel volume and quality. Year-to-year developments combined with present and potential effects of military operations will result in fuels which require an overhauling of our fuels application

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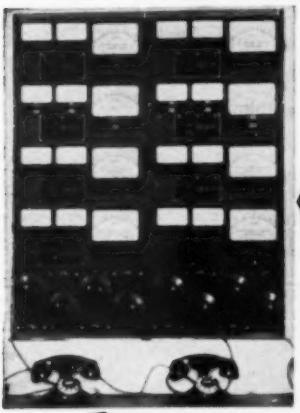

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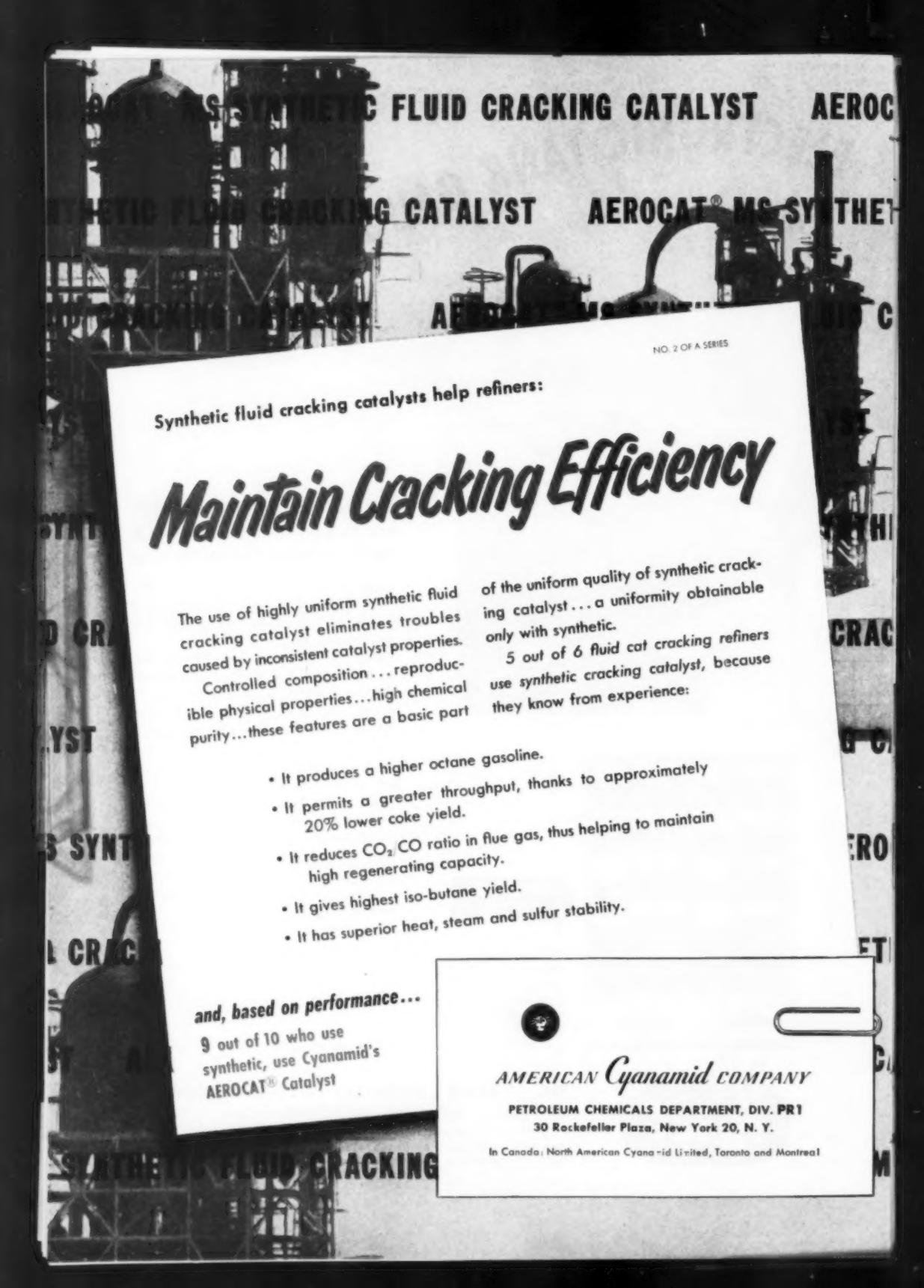

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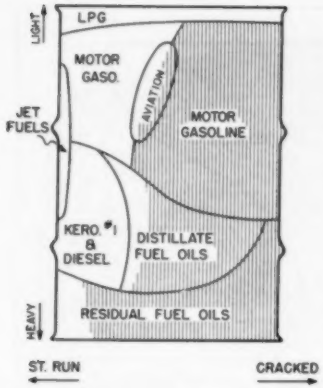


Figure 6. Inside the Petroleum Barrel (1951 Crude Run Plus 1 Million Barrels a Day). (Note: Total Fuels = 90 Percent, Remainder 10 Percent Not Shown.)

techniques. How gasoline might be utilized more effectively in the future is now considered as an example applicable to all fuels.

Engineering Analysis of Motor Gasoline

The engineering discussion which follows is obviously only the starting point in considering quality specifications for gasolines. Covered here are vehicle requirements and several variables affecting manufacturing economics. There is a great deal more to the manufacturing story including individual company refinery facilities. Competition, individual company sales programs and customer buying habits are also important factors that will finally modify the quality conclusions. On the other hand, the engineering analysis does provide a good starting point on which to consider the combination of gasoline grades that will mean the best utilization of fuel.

Since every company and every local area seem to call for gasoline quality and sales treatment different in some way from all others, it appears better to give an example of an approach to the problem rather than a complicated study intended to conclude exactly what all the figures should be.

The initial step in the analysis is the picture of passenger car vehicle requirements shown in Figure 7. The passenger car is given most of the quality attention since its needs are highest among all vehicles, and it sets the quality pace for gasoline used in truck, bus, industrial and farm engines.

The range in requirement of passenger cars in service in 1951 is shown in Figure 7. This figure has been worked out from available data on the octane requirements of cars in operation during 1951. The range of gasoline quality indicated for premium and regular is approximate. In examining the chart, it is helpful to start at the top where it is indicated that 97 octane number gasoline would eliminate knock from virtually all cars on the road. If the quality were dropped to 92 octane number, 6 or 7 cars out of 100 might be expected to knock. If the quality were dropped to 90 octane number, roughly 10 cars out of 100 might be made to knock, and so on down the chart. The knocking described in this chart is that obtained under the most severe conditions of driving and normal operation will eliminate a great deal of this knocking tendency. Furthermore, the knocking tendency of cars varies with climatic conditions, altitude and other variables, which change this picture to a certain degree from one area of the country to another.

Vehicles currently using regular and premium grades vary in their needs from below 60 to as high as 97 octane number. Analysis of data from our own files as well as from industry sources shows that the wide range of octane requirements has continued with hardly any diminution for many years and we must contend with a variation of this magnitude for some years. Getting the best combination of quality and volume for two gasoline grades, in face of this wide range, is the key to the best use of fuel, and hence is exceedingly important not only to refiners and automobile manufacturers, but to every motor vehicle owner.

Passenger Car Engine Knocking

In considering the quality of premium grade gasoline, it is necessary to realize that it is impractical to adjust this gasoline to a level where all knocking is eliminated from all cars on the road. The cost would be beyond reason. A reasonable level for purposes of this example would appear to be 92 octane number. It would leave roughly 6 to 7 percent of the cars liable to knocking under the severest conditions of driving. Suitable driving practices should avoid trouble in some of these cars. Proper adjustment and servicing would be the corrective measure for others. Where the routine services did not effect a cure, the cars might be considered "sick" and in need of careful mechanical diagnosis and perhaps internal attention.

Perhaps all this is understood among engineers, but the point should be driven home with the car dealers and the public. Raising high octane numbers can do little for a car in improper condition, but competent mechanical attention can add power and economy as well as eliminate the knock.

The goal for quality level should be to meet the needs of most new high compression engines, but not unfairly raise the cost of gasoline for the majority of older cars. Once the octane

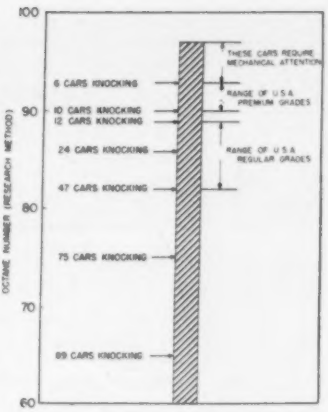


Figure 7. Variation in Octane Requirements of 100 Typical Passenger Cars. (Note: Sample of All Makes and Models in Use During 1951.)

number needs of a car have been met, nothing is gained by further increases. We have an obligation to keep down the cost of manufacturing gasoline for the majority of car owners having older cars, and at the same time to meet the critical demands of new car owners. This is a tough problem to lick.

When sales of premium grade gasoline are high it is reasonable to assume that most of the cars requiring high octane number are using premium grade, but when premium sales decrease as a percentage of the total, high quality requirement cars may be switching to regular. When they do, knocking complaints multiply and the necessity for elevating the regular grade octane number becomes apparent.

As a national average, industry premium sales now represent about 28 percent of total gasoline sold. A fairly large amount of gasoline is sold for commercial truck and bus, farm, and industrial business. Since we are considering only passenger car requirements in this example, the 28 percent of all gasoline sold as premium may be corrected to 40 percent of gasoline sold to passenger cars at service stations. This indicates that a very large share of high octane number requirement cars are using premium grade. Regular grade need not be unusually high in octane number under these conditions.

Regular Grade vs. Premium

If regular grade is too high in octane number the penalty is too high a manufacturing cost for regular grade. If regular grade is too low, it fails to meet the needs of all the cars normally consuming this gasoline. The natural tendency then is for those who are in trouble with regular to buy premium. There is a happy medium. When it is reached we

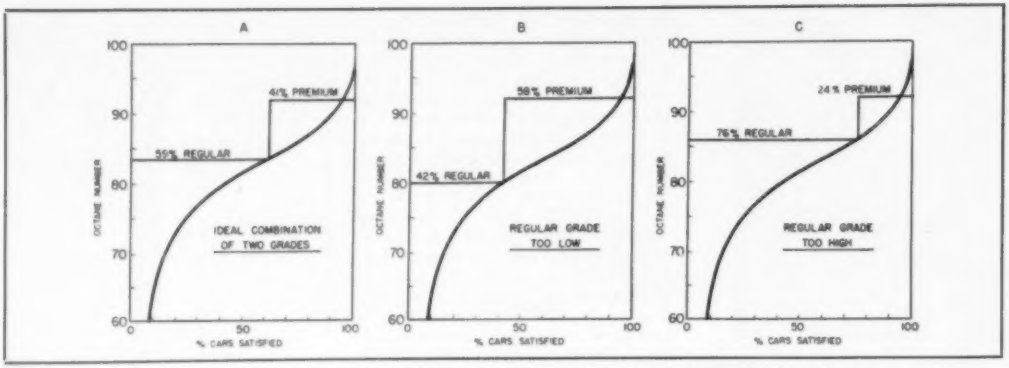


Figure 8. Comparison of Several Combinations of Regular and Premium Grades of Meet Passenger Car Octane Requirements.

serve the interests of the gasoline consuming public.

In Figure 8-A-B-C, the solid curved lines show the range in octane requirement of typical passenger cars but plotted this time so that percent of cars free of knock can be observed for any given octane number level. An assumption is made that all cars use the same number of gallons of gasoline per year. Making such an assumption makes it possible to consider gasoline consumption by gallons in relation to the passenger car octane requirements.

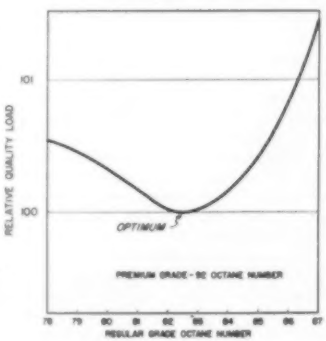
In Figure 8B we have deliberately established regular grade too low in relation to current vehicle needs. It is shown at 80 octane number compared to 92 for premium. At this low level, regular grade would meet the needs of only 42 percent of the passenger cars, requiring many cars to switch to premium and swelling premium sales to 58 percent. Not only would this be unfair to many of the car owners but it would require the manufacture of a high volume of high octane premium gasoline. For this reason and others, U. S. refineries can best carry the extra burdens of today's pressures if premium volume is a reasonable percent of the total gasoline.

In Figure 8C we have illustrated what would happen if regular grade were established at too high a level. First of all a large proportion of high octane premium components would have to be taken from premium and put into regular so as to make the necessary volume of high octane regular. To keep virtually all the cars out of knocking trouble, the distribution between the two grades would be 28 percent premium of 92 octane number and 76 percent regular of 86 octane number. As stated before, the main objection to this combination would be the high cost in money and scarce materials of manufacturing the regular grade. A less important but still significant objection to this combination is the fact that distribution costs of premium would rise sharply if premium represented only 28 percent of total passenger car gasoline.

An ideal balance in distribution of refinery quality and volume between the two grades is represented by Figure 8A. It was worked out by us at 41 percent premium of 92 octane number and 59 percent regular of 83 octane number. This spread of about 9 octane numbers between grades represented an optimum balance considering current passenger car needs and distribution of the available refinery quality ability under consideration. Bear in mind, of course, this is an example intended to show method of analysis and that there are a number of other factors to be considered before the final quality is established.

The method of analysis to reach optimum spread is given in a little more detail in Figure 9. The calculation represented by Figure 9 is made on the assumption that premium grade is 92 octane number. Regular grade is then varied in quality to see what spread between the two products results in the most efficient utilization. The vertical scale is an indication of the relative octane number load imposed on the refinery and it can be seen that the minimum load occurs at a spread between the two grades of about nine octane numbers. In a seeming paradox, a lowering of quality below a certain level fails to ease the refiner's quality problem. There is, in each case, a scientifically-arrived-at optimum for regular, and a deviation from that point raises manufacturing costs.

Figure 9. Chart Showing Octane Number (Research Method) of Regular Grade Which Results in Most Efficient Utilization of Available Refinery Quality.



It is re-emphasized that the foregoing quality and volume figures need adjustment in the light of local conditions in each part of the country and in consideration of the general sales programs under which individual companies operate. Competitive conditions and customer buying habits have a further bearing. Finally individual company refinery facilities can and do have a very substantial effect on the quality and volume of both grades. The spread in quality accordingly may vary from time to time as well as from area to area.

Wide Quality Spread for Products

While an article of this length could not do justice to the complications of refinery operations, a discussion of efficient utilization of gasoline quality should include a connecting link to the cracking trend pictured in the early part of the paper.

Finished gasoline is generally a blend of three principal stocks: low octane, made up largely of heavy straight run; intermediate, largely thermally cracked; and high octane, largely catalytically cracked but including smaller amounts of alkylate, polyform, hydroformed, catalytic poly, reformed, and light straight run. Roughly, it may be said that the leaded (3 cc. per gallon) octane number of the low-octane stocks is 70 to 85, the intermediates are 78 to 86 and the high-

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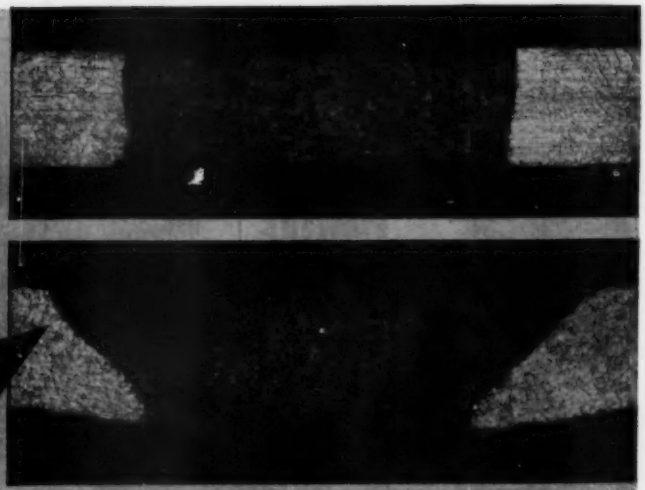

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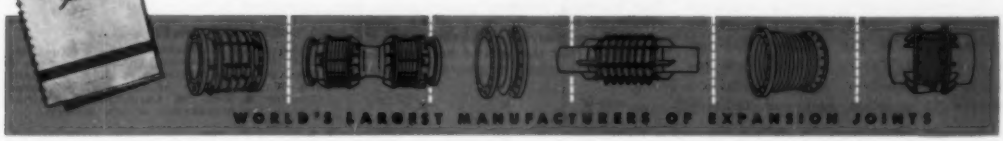


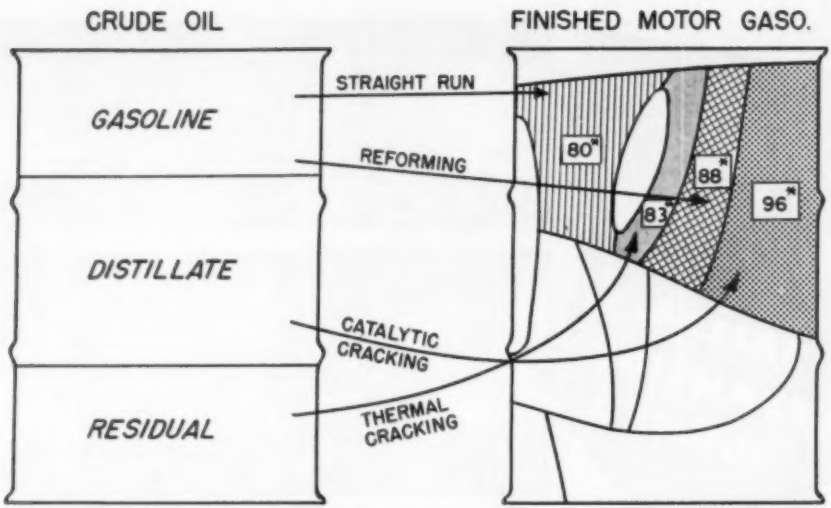


Figure 10. Source and Quality of Stocks Blended to Make Finished Gasoline. (*Research octane number values shown are examples. Actual refinery stocks vary as follows: Straight Run 70-85; Thermal 78-86; Reformed 82-98; Catalytic 92-98.)

quality stocks are 92 to 98 by Research Method.

Generally speaking, the low-octane stocks are elevated by blending them with the intermediate or high quality gasolines. If a large percent of high quality stocks is used to blend up to a high quality regular, high quality stocks are somewhat degraded and thus made unavailable for the premium trade; whereas, if the regular grade is maintained at a reasonable quality level, less of the premium stocks are needed, and they are saved for top quality needs.

Many refiners are now installing additional reformer capacity to convert heavy straight-run from low octane to high quality. These units are effective in elevating quality, but they are very expensive to install and operate. The need for them would be minimized to the extent that the most efficient quality spread between regular and premium grade is applied. Figure 10 helps illustrate this point. This is a schematic diagram to show how finished motor gasoline is made up of blends of low, intermediate, and high octane number stocks. The octane numbers are leaded values and again are offered by way of illustration, rather than exact numbers which would apply to any particular refinery.

Summary

To record-breaking civilian demands are added the burden of upset conditions in Iran and of the defense program. For the near future at least, new refinery construction appears limited largely to aviation fuel and military projects. With the pinch already felt in some fuels, engineers should study refinery trends and see if we can make more effective use of the quality and volume of petroleum stocks available under present conditions.

Among the significant trends is the development of the long term cracking trend to the point where middle distillates are now predominantly cracked. Another outstanding trend, complicated by today's conditions, is the difficulty of manufacturing high octane gasolines, plus the high cost per octane number, as the quality reaches up into the 90-plus range.

A method of analysis has been offered herein using motor gasoline as an example, whereby refinery ability may be more efficiently applied to today's conditions of gasoline consumption. Making certain assumptions for this illustration, the example brings out the following:

A) Premium gasoline quality cannot be manufactured economically to an octane number which eliminates knocking from all passenger cars, but adequate mechanical service know-how has been developed to eliminate the knock from the troublesome vehicles.

B) Premium gasoline sales volume is currently high enough to warrant a fairly wide spread in quality between premium and regular grades—wider than that existing in many parts of the country today. The engineering analysis, which is subject to a number of qualifications as outlined in the paper, indicates that available refinery quality would be employed most efficiently if the quality stocks were distributed between the two grades so that the spread between them was about 9 octane numbers. The analysis indicates further that efficiency is sacrificed if premium sales fall below the present national figure of about 28 percent of total gasoline (about 40 percent of gasoline for passenger cars). When the proposed method of analysis is applied by any one company in consideration of its own sales and manufacturing programs, the figures probably will come out with some adjustment from the numbers which have been mentioned. Nevertheless, the principle of analysis and the objective of a fairly wide quality spread are sound.

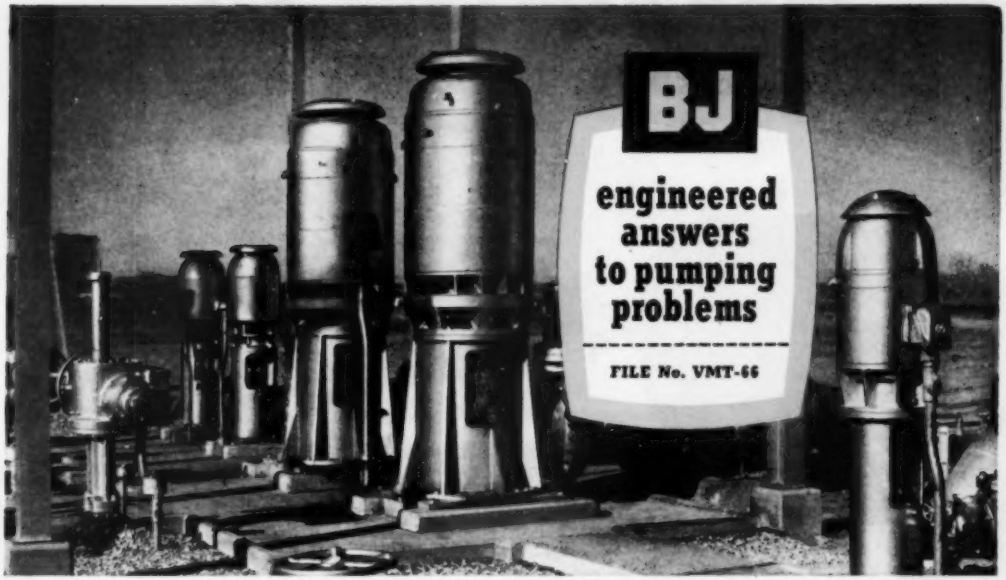
C) The oil industry is rapidly reaching the point where further quality increases mean a loss in the percentage of quality gasoline. This fact, plus the refinery problem of disposing of low octane gasoline stocks, is a further strong argument in favor of an efficient combination of grades and a reasonably wide quality spread.

A similar method of analysis for other fuels, such as, diesel and No. 2 fuel oil may also show benefits which ultimately could be passed along to the consumer.

One interesting angle has developed in studying the possible implications of an accelerated military program. A substantial increase in the manufacture of jet fuels would mean refinery expansion of a type which would contribute little to the quality of gasoline which could be made for later peace-time automotive consumption; whereas, construction to produce aviation gasoline in World War II is estimated to have contributed the equivalent of 5 octane numbers to improvement of motor gasoline.

ACKNOWLEDGMENT

The author is indebted to L. Steffens and G. B. Calkins of Socony-Vacuum Research & Development Laboratories and to H. S. Kelly and W. R. Grosser of the Socony-Vacuum Gasoline & Fuel Oil Department, for their help in the preparation of this material.



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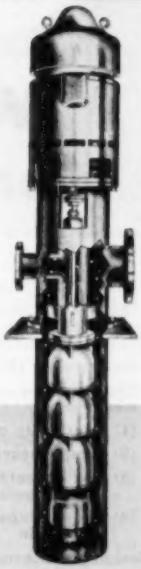
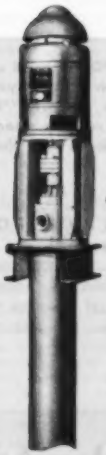
When pumping fluids at boiling point temperatures, the problem of sufficient net positive suction head often requires expensive installation to raise the vessel from which the pump would draw or to excavate a pit to lower the pump.

This is eliminated with the BJ "VMT" pump because the vertical multi-stage pumping unit is mounted in a barrel from which it takes a suction. The base of the pump is at ground level while the length of the barrel is determined by the NPSH requirement.

The "VMT" pumps (shown above) serving as boosters from gasoline tank farm to main line stations are just one of the many successful applications for refineries, pipe lines, fueling stations, power plants, and process industries. For more detailed information on how the "VMT" may solve your pumping problem, call your local BJ sales office or send the coupon below.





FILE FACTS:

- Capacities to 5000 gpm. Heads to 250 psi. Temperatures from sub-zero to 750° F.
- Handles corrosive or non-corrosive liquids
- Radial forces balanced at all speeds
- Adjustable coupling for easy, accurate impeller setting

Also available in the smaller "VLT" model (capacities to 110 gpm). Provides the same basic construction and installation advantages as the "VMT," yet is priced for general purpose application.

Byron Jackson Co.

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OFFICES IN PRINCIPAL CITIES

BJ Pump Division, Dept. 27

Please send me Bulletin No. 51-6600 on your VMT pump.

NAME_____

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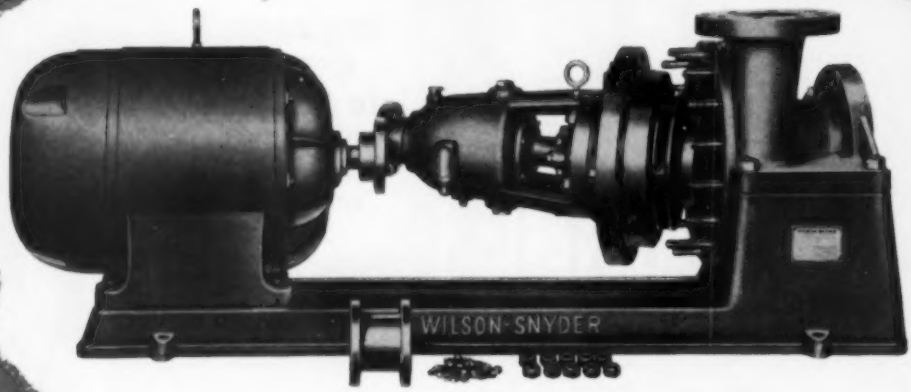
Look how EASY it is...

to dismantle for inspection or repair



Wilson-Snyder Type ES Centrifugal Process Pumps

BY REMOVING the coupling spacer and nuts from the case-parting flange, Wilson-Snyder Type ES single-stage, single-suction process pumps, with vertically split case, can be dismantled for inspection without disturbing the driver or the piping.

These pumps are specifically designed for services where:

(1) continuity of operation is very important

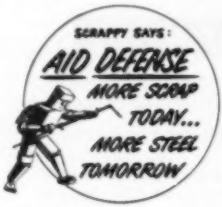
(2) temperatures or pressures may be very high

(3) hot or cold liquids are handled near their boiling points

(4) broad capacity range at high efficiency is desirable

Design permits maximum interchangeability of parts. Only 3 sizes of bearing brackets, sleeves, packings, shafts and bearings are required for all 18 pump sizes, which provide capacity ranges from 40 to 1800 gpm with differential heads from 40 to 1000 feet and a speed range from 1750 to 4000 rpm with horsepower range from 2 to 250.

"Trims" can be furnished of any commercially available material which can be cast and machined, but standard stock materials include (a) 40,000-pound tensile cast iron, (b) low carbon cast steel, (c) 13% chrome stainless, type 410, (d) 18-8 stainless, types 304 and 316, (e) acid-resisting bronze, (f) 18-8 Stellited wear faces, (g) 4140 HT shaft and studs and (h) spark proof monel glands.



FOR FULL INFORMATION . . . or quotations on Wilson-Snyder Process Pumps, contact "Oilwell's" nearest refinery specialist at area office points shown below.

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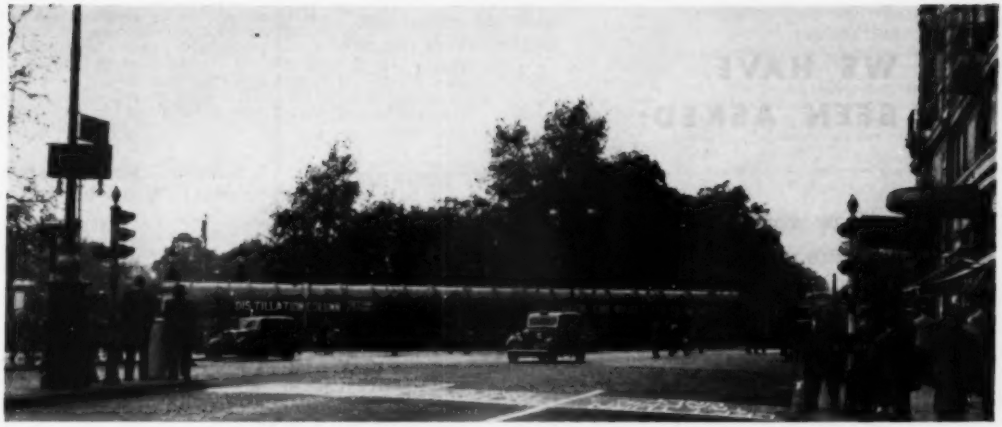


PASSING THROUGH LONDON this 132-foot-distillation-column is shown in the photo above as it was being maneuvered from Park Lane, London, across Marble Arch during the early stages of its 400 mile journey to the Forth Chemicals, Ltd., refinery at Grangemouth, Scotland.

News Notes On Refinery and Other Plant Construction

Petroleum Refiner's quarterly "Box Score" feature appears next in the April issue

Pemex Starts Construction Of Salamanca Lube Unit

Petroleos Mexicanos will start construction during this quarter of a new lube plant to be located at Salamanca. The plant, estimated to cost $20 million, will have a manufacturing capacity of 2400 barrels of lube oils daily, and 140,000 pounds per day of paraffin waxes. A. G. McKee & Company were contracted for the engineering and construction responsibility last year, but work was held up due to material shortage.

At Atzcapotzalco and Ciudad Madero the desulfurization plants are expected to be completed during February or March. No definite plans have been announced for the refineries which would serve the West Coast area, but locations mentioned have been: Salina Cruz in Oaxaca, Mazatlan in Sinaloa, and Guaymas in Sonora.

Southwestern to Modernize Corpus Christi Refinery

Southwestern Oil and Refining Company has authorized The Refinery Engineering Company of Tulsa to construct a UOP catalytic cracking unit, a gas concentration plant, a polymerization plant and a product treater, at their Corpus Christi, Texas, plant. The modernization program will give the plant a design capacity of 5740 barrels of gas oil charge daily at 50 percent conversion. Initial capacity of the blowers has been increased 30 percent over design requirements, and the fractionating column will be one foot larger in diameter than required by design.

So-Vac Licenses Europe's First Bead Catalyst Plant

Construction of a plant to manufacture bead catalyst for Thermofor catalytic cracking units in Europe is under way at Nienberg, near Hanover, Germany, licensed by the Socony-Vacuum Oil Company, Inc. The Kali-Chemie Company is erecting the plant which was patterned after Socony-Vacuum's original bead catalyst plant at Paulsboro, N. J.

By the end of 1952 the Nienberg plant will be in operation and able to supply the TCC unit completed last year at Frontignan, France. Eventually it will supply ten other TCC units planned for Europe and one planned for Morocco.

Gulf to Add Acid Recovery, Poly Unit at Port Arthur

A new sulfuric acid and polymerization plant to be erected at Gulf Oil Corporation's refinery at Port Arthur, Texas, will be built by Leonard Construction Company, Chicago, and Bechtel Corporation, San Francisco, respectively.

The acid plant will have a capacity of 300 tons per day, manufacturing acid from sulfur by contact method. It will also include acid sludge decomposing units for decomposing spent acid. Both processes are based on Monsanto Chemical Company design. The polymerization plant, for manufacture of high octane gasoline from propylene, and also production of high polymers, utilizes a phosphoric acid catalyst. Construction on both units will begin in April, with completion scheduled for 1952.

Kansas Refinery Starts Crude Expansion Project

A major expansion project at Potwin, Kan., will raise the crude run capacity of the Vickers Petroleum Company, Inc., to 10,000 barrels a day. The expansion, which is already launched, will be completed by January, 1953, and will include an increased crude run as well as the addition of a Thermofor catalytic cracking unit. A pipe line to El Dorado, Kan., is being built to carry the products to the Great Lakes Products Pipe Line System; in addition the company's home office is being transferred to Wichita.

Engineering and construction of the project will be handled by the Southwestern Engineering Company who will use a Sweco packaged 6M TCC unit, designed in conjunction with Socony-Vacuum Oil Company.

Ponca City Modernization Of CS Plant Completed

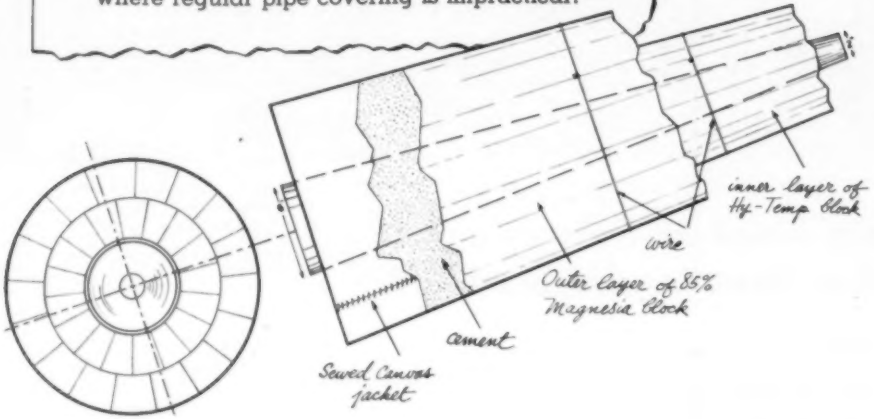
Modernization of the Ponca City, Okla., refinery of the Cities Service Oil Company of Delaware has been completed and the 8350-barrel-a-day Orthoflow catalytic cracking unit is already in regular operation. The program included work on the crude vacuum unit which raised the plant capacity by 5000 barrels to 20,000 barrels daily. The M. W. Kellogg Company installed the Orthoflow cracking unit.

AIOC to Build Refinery On West Australian Coast

It has been announced that Anglo-Iranian Oil Company is planning a $112 million refinery construction project to be started south of Fremantle, on the west coast of Australia, very shortly. Capacity of the plant will be designed for up to three million tons of Middle East crude annually. Australia, engaged

WE HAVE BEEN ASKED:

"How would you insulate a tapered reducer where regular pipe covering is impractical?"



A power engineer wrote to us recently and outlined this problem: "We plan to insulate a 6" x 2" x 30" tapered reducer which carries steam at 350 lbs. pressure (725° F.) between a pressure reducing valve on a 2" superheated steam line (1000° F.) and a de-superheater. What insulating materials do you recommend and how should they be applied?"

To answer this question, we sent the drawing above and the following recommendation: To minimize heat loss on the 2" superheated steam line, regular pipe coverings of Hy-Temp and 85% Magnesia should be used. These are applied in two 2" layers according to standard specifications for this 1000° F. temperature. On the tapered reducer, the same insulation thickness is used. Here, however, blocks of insulation are applied instead of preformed pipe covering. These must be cut and carefully fitted around the conical shape, then wired securely in place. The layer of Hy-Temp is applied first. This reduces the temperature on its outer surface to a point within the 600° F. temperature limit of the 85% Magnesia, which is then applied to further cut down heat loss. As is the case with the layers of pipe covering, inner and outer joints should be staggered to prevent through joints that result in heat leakage. Joints should be filled in and smoothed with cement. A sewed canvas jacket completes the job.

The next time you have any insulation work to be done, you'll find that Armstrong's thorough knowledge of insulation and its uses can help you. Our Contracting Service can handle the entire job for you—furnish fine-quality materials and the skilled workmen to apply them properly. For further information, just contact your nearest Armstrong office.

SEND US YOUR QUESTION. If you have any questions on insulating materials or their use in high- or low-temperature installations, please write us. We'll see that you get a prompt, practical answer. Address your letter or post card to Armstrong Cork Company, 7502 Maple Street, Lancaster, Pennsylvania.

ARMSTRONG'S INDUSTRIAL INSULATIONS

MATERIALS - INSTALLATION

FOR ALL TEMPERATURES FROM 300°F. BELOW ZERO TO 2800°F.

in a five year program of stepping up its industrial potential, has attracted $200 million in oil refinery programs to date. Standard Vacuum will spend $16,800,000 to expand present holdings; Caltex companies has announced a $56 million program; and Shell will undertake a $10 million program.

Avgas Facilities Included In Revised Tax Writeoffs

Under a revised system of priorities of Defense Production Administration for processing certificates of necessity for rapid tax amortization aviation gasoline facilities and selected petroleum products will be considered in the top category along with 13 other types of defense production facilities.

Categories were heretofore accorded preferential treatment according to the sequence of which they were classified by DPA, with machine tools in first place and aviation gasoline facilities in eighth position. Under the new system all classifications are treated alike and no one category will rate preferred treatment unless current exigencies of a particular expansion program require it.

See accompanying table presented immediately below.

Construction Begun on Refinery in North Italy

Under construction in northern Italy's Po plain is a 13,000-barrel-daily refinery being built for Societa per Azioni Raffineria Padana Olii Minerali (Sarpom), an organization equally owned by Caltex companies and Fiat. Facilities for the plant will include distillation, thermal reforming and treating equipment units.

Production will include 2730 barrels daily of motor gasoline; 720 barrels of kerosine; 860 barrels automobile diesel; 1250 barrels of industrial diesel; and 6720 barrels of fuel oil.

The refinery is situated at San Martino di Trecate in the heart of the industrial north, close to Milan, and crude will be piped from the port of Savona, 97 miles away, through an 8-inch pipe.

Longview Plant Producing Chemical Raw Materials

At Longview, Texas, the Texas Eastman Company plant is in partial operation producing chemical raw materials to be used at the Kingsport, Tenn., plant owned by Tennessee Eastman Company. Humble Oil & Refinery Company has begun delivery of from 25,000 to 60,000 gallons of propane daily, and will eventually delivery 80,000 gallons daily as raw material for the Longview plant. It also is delivering four MMcf. of gas daily. In full operation the plant will use 10 MMcf. of gas each day.

Fast Tax Write Offs

COMPANY AND LOCATION	Type of Facility	Amt. Amort. Applied For	Amount Certified	Percent Allowed
Ashland Oil & Refining, Kenova, W. Va.	Storage	$ 590,000	$ 590,000	40
Ashland Oil & Refining, Owensboro, Ky.	Storage	300,000	300,000	40
Ashland Oil & Refining, Marietta, Ohio	Storage	52,500	52,500	40
Ashland Oil & Refining, Toledo, Ohio	Storage	125,000	125,000	40
Ashland Oil & Refining, Covington, Ky.	Storage	141,300	141,300	40
Ashland Oil & Refining, Wood River, Ill.	Storage	240,000	240,000	40
Ashland Oil & Refining, Clarksville, Ind.	Storage	209,500	209,500	40
Esso Standard Oil, Everett, Mass.	Gasoline	6,776,000	3,957,000	65
			819,000	50
Socony-Vacuum Oil, Paulsboro, N. J.	Gasoline	7,500,000	4,268,000	65
			3,232,000	65
Davidson Chemical, Baltimore, Md.	Petroleum Catalyst	210,494	210,494	75
Pure Oil Company, Toledo, Ohio	Sulfuric Acid	2,560,000	32,000	40
			2,478,000	90
Johnson Oil Supply, Gary, Ind.	Gasoline	1,598,000	198,000	45
			1,400,000	65
Cooperative Refinery Assoc., Phillipsburg, Kan.	Refinery	2,750,000	398,000	45
			2,282,000	65
El Dorado Refining, El Dorado, Kan.	Gasoline	2,965,900	710,000	40
			2,255,900	65
Derby Oil, Wichita, Kan.	Storage and Transfer Line	209,900	209,900	40
Vickers Petroleum, Potwin, Kan.	Gasoline	2,586,000	450,000	45
			2,136,000	65
Phillips Oil, Okmulgee, Okla.	Gasoline	4,500,000	3,464,000	65
			1,036,000	40
Esso Standard, Baton Rouge, La.	Iso-octyle and tridecyl alcohol	3,000,000	2,760,000	70
			240,000	50
Humble Oil & Refining, Baytown, Tex.	Gasoline	132,500	132,500	65
Humble Oil & Refining, Baytown, Tex.	Gasoline	329,600	329,000	65
Humble Oil & Refining, Baytown, Tex.	Butylenes	85,191	59,755	65
			25,436	50
Humble Oil & Refining, Baytown, Tex.	Gasoline	570,000	495,000	65
			75,000	50
Humble Oil & Refining, Baytown, Tex.	Gasoline	1,090,000	870,000	65
Humble Oil & Refining, Baytown, Tex.	Sulfuric Acid	908,000	588,000	70
The Texas Company, Amarillo, Tex.	Aviation Gasoline	20,750,000	2,250,000	90
			9,995,000	65
			8,300,000	45
			205,000	15
The Texas Company, Port Arthur, Tex.	Gasoline	1,286,000	236,000	40
			1,050,000	65
Gulf Oil, Crane County, Tex.	Sulfur	290,000	203,000	70
Mid-Continent Petroleum, Tulsa County, Okla.	Aviation Gasoline	119,572	119,572	90
Shell Chemical, Houston, Tex.	Synthetic Glycerine	1,514,500	1,173,600	75
			188,000	45
Republic Oil Refining, Texas City, Tex.	Gasoline	6,645,000	152,900	15
			2,650,000	40
			2,820,000	65
			1,105,000	40
			70,000	15
Phillips Petroleum, Midland County, Tex.	Gasoline	9,608,000	3,110,000	40
			6,498,000	65
Morton Salt Company, Weeks, La.	Petroleum Products	1,970,179	157,256	50
			1,749,520	75
Phillips Petroleum, Woods Cross, Utah	Gasoline	5,706,000	3,172,300	65
			2,126,200	40
Frontier Refining, Cheyenne, Wyo.	Alkylate	2,570,000	486,000	45
			1,100,000	65
			926,500	90
Mohawk Petroleum, Bakersfield, Calif.	Jet Fuel	3,000,800	53,000	40
			2,947,000	65
Pan-Am Southern, El Dorado, Ark.	Gasoline	2,895,000	118,000	90
			2,210,000	65
			467,000	45
			100,000	15

OEEC Expects New Peak For U. K. Refining Capacity

It is estimated that United Kingdom refining capacity at the end of 1952 will be 56,600 barrels a day greater than that estimated by the Organization for European Economic Cooperation earlier this year. The OEEC foresaw a capacity of 400,000 barrels daily at that time. The increase may be due in part to accelerated expansion, speeded up after the Abadan shutdown, as well as stepped up throughput of existing facilities.

Next June, Anglo-Iranian's refinery at Kent, England, is due to come on stream with 38,000 barrels daily capacity, with an extra 19,000 barrels scheduled by the end of 1952. In addition, the Coryton, England, refinery of Vacuum Oil Company will be completed in 1952. The new refineries, plus expansion capacity of existing facilities, should bring the total refining capacity to 484,600 barrels per day.

Refined products in the United Kingdom were valued at $64.4 million at the end of last October, to compare with a $30.8 million value for a similar period in 1950.

Solvay Division Plans Texas Petrochemicals Unit

Land has been purchased near Orange, Texas, by the Solvay Process Division of Allied Chemical and Dye Corporation for the erection of a new plant to manufacture ethylene glycol and ethylene oxide. Estimated to cost $5 million, the plant is scheduled to be in operation about 18 months from the time construction gets under way. The plant will be supplied by pipe line from the Port Arthur refinery.

So-Vac Schedules Program For High Octane Gasoline

Socony-Vacuum Oil Company has announced a $27 million construction program that will produce a total of 37,000 barrels daily of high octane gasoline when completed. The program concerns the erection of a catalyst manufacturing plant at Paulsboro, N. J., and the installation of Thermofor catalytic reforming and other facilities at Beaumont, Texas; Augusta, Kan.; and Torrance, Calif. The program is waiting government approval before actual work can begin.

Modernized Berre, France, Refinery on Stream Again

On stream again after a modernization program which elevated it to one of Europe's most advanced refineries, the Shell-Berre refinery at Berre, France, now has a crude run capacity of 65,000 barrels daily. The new plant comprises a topping and a reforming unit as well as additional storage and

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transport facilities. A fluid catalytic cracking plant with a capacity of 8612 barrels daily, and a petrochemical plant for production of acetone, isopropyl alcohol and other organic products will be added.

Kaiser Engineers Studying Project at Texas City

Engineering studies for the modernization of the Texas City Refining plant at Texas City are underway by Henry Kaiser Engineers, a division of the Henry Kaiser Industries of Oakland, Calif. Estimated to cost about $3 million, the program will be completed sometime in 1953.

The plant, built during the war by the Defense Production Corps, was purchased by the Petrol Terminal Corporation in 1947, and after rehabilitation was placed on stream in February, 1948, with a capacity of 50,000 barrels daily. The firm was renamed Texas City Refining Inc. in 1951 to avoid confusion with other refining companies who used "Petrol" in their title.

Jersey Standard Expands Ebano Refinery in Germany

Contracts for the general expansion of its Ebano refinery at Hamburg, Germany, have been let by Standard Oil Company (New Jersey). Standard Oil Development Company will handle the engineering of the $10 million project, and Gutehoffnung-Shutte, of Oberhausen, will do the construction work. The expansion is scheduled for completion in January, 1954, bringing the refinery capacity to 32,000 barrels daily.

Polyethylene Resins Unit Scheduled for Texas City

About 50 million pounds a year of polyethylene resins will be produced by Carbide and Carbon Chemicals Company at its Texas City plant upon completion of a new petrochemicals unit. The National Production Authority has issued a certificate of necessity and the project will get under way immediately, with completion scheduled for early 1953.

Kermac Leases Sunray's Non-Operating Asphalt Unit

Kerr-McGee Oil Industries, Inc., has contracted for the rights to process, produce and market asphalt from the Sunray Oil Corporation plant near Duncan, Okla., and Kermac crews have already put the unit in operation. The Duncan unit will boost Kermac production to around 5500 barrels daily. Sunray has been sending its asphalt base crude oil to the Kermac plant at Wynnewood.

Shell Chemical Plant Near Houston in Operation

Installations increasing synthetic glycerine output by 50 percent, and ethyl chloride output by 30 percent, have been completed at the Houston plant of Shell Chemical Corporation. The ethyl chloride addition necessitated an increase in the production of ethylene before the units for the manufacture of these vital chemicals could reach scheduled capacity.

Second Orthoflow Cracker In Operation at Ponca City

Regular operation of the 8350-barrel Orthoflow catalytic-cracking unit erected by Cities Service Oil Company at its Ponca City, Okla., refinery, was begun recently. The expansion program just completed brought the refinery's capacity up to 20,000 barrels of crude daily. The Orthoflow unit, second to be erected, was designed and installed by The M. W. Kellogg Company. The original unit is in operation at Edmonton, Canada.

Construction

Coal Company to Build Large Carbonization Plant

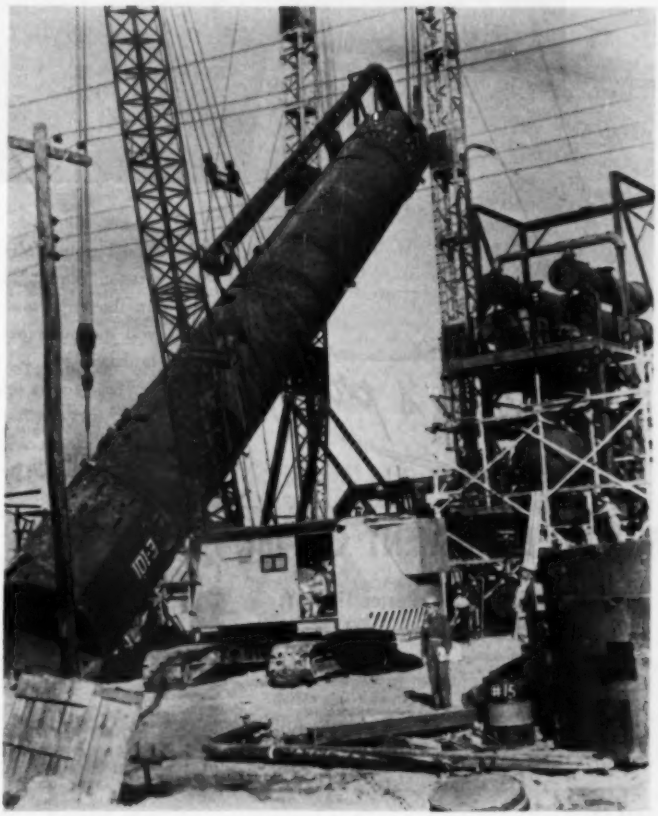
Work on a large pilot plant planned by the Pittsburgh Consolidated Coal Company at Library, Pa., will be undertaken by the Chemical Plants Division of Blaw-Knox Company for completion in late 1952. The plant, to be built at the company's research center to augment work on the low temperature coal carbonization process, will provide information on cost and design data for a commercial plant, and permit sufficient quantity production of liquids to permit commercial evaluation of the chemicals and special carbons obtained.

Refined by special carbonization processes, tar liquid yields low-boiling tar acids, creosotes or feed stock for making carbon black, and electrode carbons, according to the company.

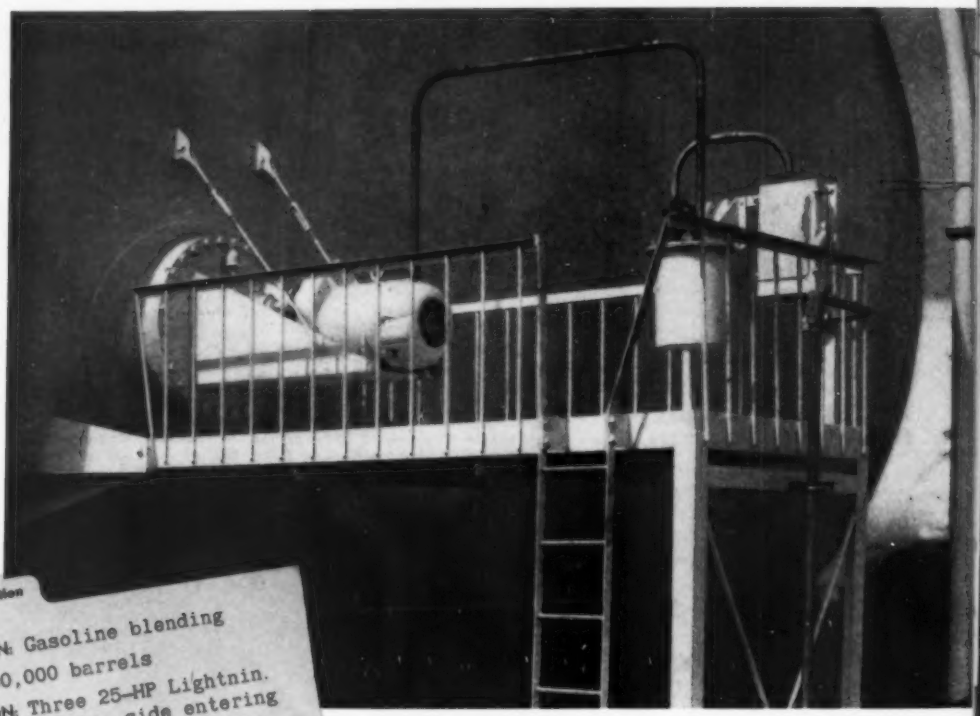
Iraq Completes Agreement With AIOC Subsidiaries

Iraq and two subsidiaries of the Anglo-Iranian Oil Company, Khanaqin Oil Company and the Rafidain Oil Company, have reached a satisfactory agreement with regard to petroleum operation in that country. The Iraq government has bought distribution facilities and the Alwand refinery at

RAISING THE MAIN FRACTIONATOR for the new Orthoflow Fluid catalytic cracker now under construction for Canadian Oil Refineries, Ltd., at Froomfield, Ontario, a crew of The M. W. Kellogg Company's subsidiary, Canadian Kellogg Company, Ltd., near completion of an important part of the new refinery. The over-all supervision is being handled by Stone & Webster, Canada, Ltd., and the unit is scheduled for completion during March. Refinery products will be marketed by Canadian Oil Companies, Ltd.



MORE TANKFULS *from the* same tanks



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TANK: 100,000 barrels

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fair valuation, allowing the Khanaqin company to operate the refinery until 1961. In the meantime the government will build a government-owned refinery at Baghdad. The AIOC company will supply the Alwand refinery with operating crude from the crude oil area over which it retains drilling and production rights.

In addition the company will build a government plant at Basra to process products for the southern Iraq market. When the government refinery at Baghdad is on-stream the Khanaqin company will be free to export its production.

AEC Uranium Processes Under Development Survey

An intensive survey of the Atomic Energy Commission's uranium feed materials production processes will be ducted by Catalytic Construction Company, Philadelphia, as part of a comprehensive program designed to improve existing processes and develop new ones. Scientists and engineers of Houdry Process Corporation, Philadelphia, will aid in the project which is being headed by Witney Weinrich, chief process engineer for Catalytic at the AEC Feed Materials Production Center under construction near Cincinnati.

Refinery Engineering Given Eldorado Cracking Project

Contract for the construction of a catalytic cracking unit, a gas-concentration plant, and revamping of the polymerization plant at El Dorado, Kan., has been awarded Refinery Engineering Company by Eldorado Refining Company. The $3 million project will bring the refinery's cracking capacity from 9000 barrels daily to a possible 15,000 barrels.

Pure Oil Adds Catalytic Cracking at Toledo Plant

Pure Oil Company will begin construction on its 10,500 barrel catalytic cracking unit at Toledo by May 1. Preliminary plans have been made also for the erection of a $2,560,000 alkylation unit which the Defense Production Administration certified recently. Construction of the alkylation unit will get under way as soon as possible.

Field Construction Begun At Imperial's Ioco Plant

Construction on the $13.5 million Imperial Oil, Ltd., expansion program at Ioco, Canada, will begin early this spring, with completion scheduled for late fall 1953. Upon completion the refinery will have a capacity of 22,500 barrels a day, compared to 12,000 barrels a day now. Most of the existing process units will be replaced with new equipment, including a 7500-barrel-a-day fluid catalytic cracking unit.

Add Petrochemicals Unit

A "major unit" to manufacture 50 million pounds yearly of polyethylene plastics at Texas City has been announced by Union Carbide & Carbon Corporation. It is estimated the plant will be completed early in 1953 and that all production will be used for military materials.

Chemical Company Announces Entry Into Petrochemicals

A new process by which phenol can be made from hydrocarbons of petroleum and cresols derived from naval stores has caused the entry of Hercules Powder Company of Wilmington, Del., into the petrochemical field. The company will build a $8 million plant in the Delaware River area for the manufacture of phenol, para-cresol and acetone. The importance of the new method is its use of organic hydroperoxide to provide oxygen required. It does not entail the use of chlorine or sulfuric acid used in other methods. The process was developed by a Hercules experiment station, and rights to a similar process developed simultaneously by Distillers Company, Ltd., of England have been secured by Hercules. B. A. Shawinigan, Ltd., has been licensed to use the process and has announced plans for a plant in Montreal.

Expanded Gasoline Plant In Operation at Ulysses

Operations will begin this month at the Ulysses, Kans., Stano Gasoline Plant which Stanolind Oil and Gas Company has been expanding. Originally the plant had a capacity of 125 MMcf gas per day and the new facilities will make possible the processing of 325 MMcf gas every 24-hour period.

The expansion program was carried out on a tract adjacent to the older plant which was in operation during the expansion program. Among units included in the expanded section are a deisobutanizer tower, 136 feet high, as well as storage in the form of horizontal and sphere tanks which will permit storing 510,000 gallons of gasoline, 150,000 gallons of iso-butane, 340,000 gallons of propane, and 420,000 gallons of normal butane. The gasoline will be refined into motor fuel; the liquefied petroleum gases will be distributed throughout the area, and the dry gas remaining will be sold to a gas pipeline for domestic and industrial use in Kansas and Missouri.

The plant is now the largest of the 13 gasoline and cycling plants operated by Stanolind in the Mid-continent area.

Installing Power Units at African Liquid-Coal Plant

Power and process steam for the first commercial plant making high-octane gasoline from coal will be supplied by four large boilers, to be installed by Combustion Engineering-Superheater, Inc., of New York, at the South African Oil and Gas Corporation, Ltd., plant at Johannesburg, South Africa.

The M. W. Kellogg Company is acting as overall project manager for this project which has utilized the services of firms from all over the world.

South Africa does not possess any major petroleum reserves, but does have tremendous deposits of available coal and successful utilization of coal deposits will make the country at least partially independent in the matter of liquid fuels.

Announce Skimming Unit

Capacity at Western Reserve Refining Company's Niles, Ohio, refinery will be increased to 6000 barrels a day with the addition of a new skimming unit which will be erected by Catalytic Construction Company. With completion scheduled for March 1, the refinery will realize a capacity increase of 3800 barrels a day.

Construction

Huge Capacity Gain Noted By Ashland O&R in 1951

Reporting a throughput gain of nearly 50 percent, Ashland Oil and Refining Company reported that the average for 1951 was 93,174 barrels daily to compare with 62,605 barrels daily in 1950.

At the Canton, Ohio, refinery, operation of new facilities, including a new catalytic cracking plant, will begin this quarter, with the revamped crude unit showing a 40 percent increase in crude run capacity. Further constuction on the Frontier refinery at Buffalo, N. Y., will be completed in 1953 at a cost of about $5 million. At Catlettsburg, Ky., construction under way will permit increased crude run, will increase the cracking capacity to 27,000 barrels daily, and will double the present vacuum distillation facilities. In addition a unit for the manufacture of aviation alkylate is being installed.

Petrochemical Plant Set For Completion Next Year

Groundwork on a new vinyl chloride monomer plant at Calvert City, Ky., has been started, according to B. F. Goodrich Chemical Company, and the plant will be completed by late 1952 or early 1953. It will supply the Avon Lake, Ohio, Geon resin plant which was finished last July, and will supplement supplies from the Geon resin plant at Louisville.

TCC Unit Under Construction Near Sao Paulo, Brazil

Hydrocarbon Research, Inc., has begun construction of a 25,000 barrel a day Thermofor catalytic cracking unit at the Refinaria E Exploracao de Petroleo Uniao S. A. plant at Capuava, 20 miles from Sao Paulo. The process is licensed by Socony-Vacuum. Pipelines carrying crude from the coast, rise 3000 feet to reach the plateau on which the plant is located.

M. W. Kellogg Announces AEC Project at Paducah

The M. W. Kellogg Company has announced it will handle a $75 million contract installing field-fabrication, process and auxiliary piping, and related equipment in the two major gaseous diffusion units being erected at Paducah, Ky., for the Atomic Energy Commission.

Refining Capacity Forecast

The domestic refining capacity was expected to be 7,228,000 barrels a day at the year's end and should be 7,365,000 barrels a day by next September 30, according to the latest American Petroleum Institute survey. The capacity as of the past September 30 was 7,227,400 barrels daily.

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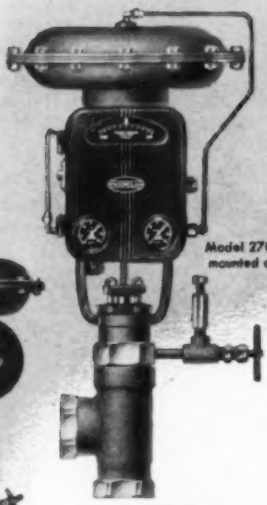
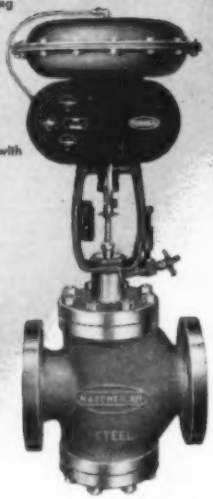
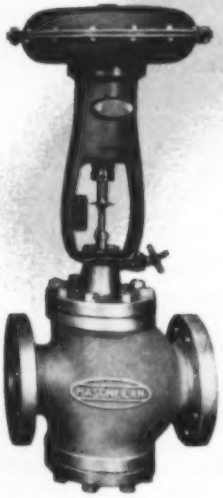


Model 2707 Pressure Controller mounted on control valve.



10000 Series Control Valve with Series 7400 Positioner.



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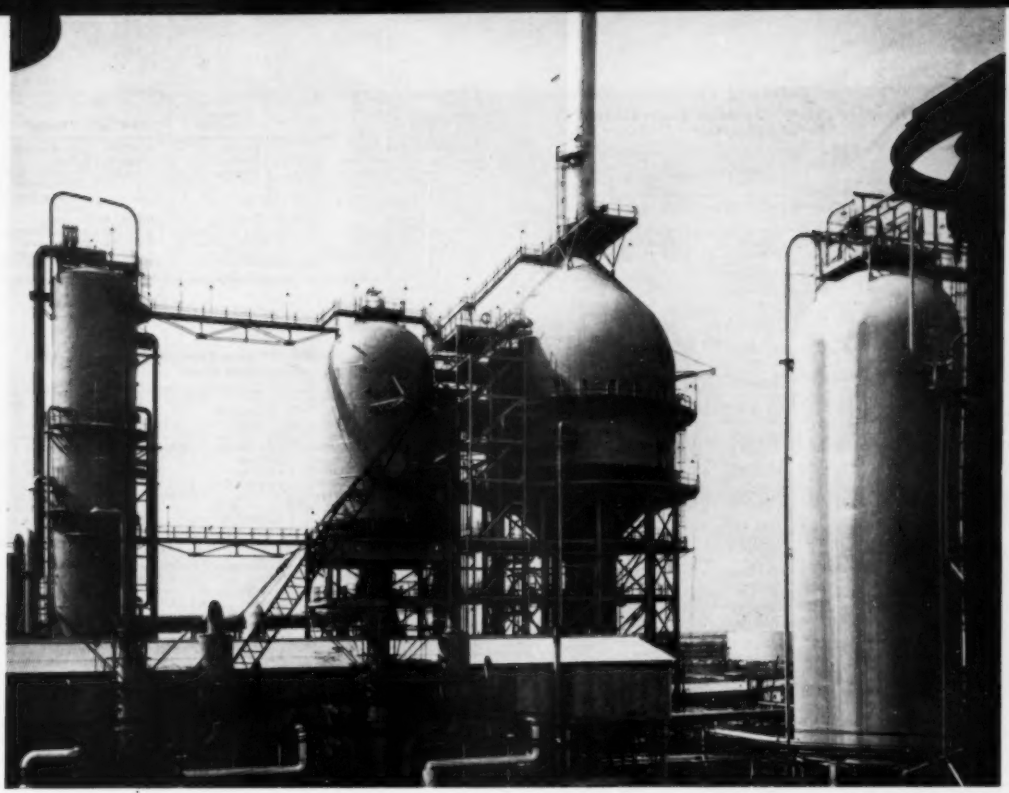


The latest addition to Gulf Oil's Port Arthur refinery is this 60,000 bpd catalytic cracking unit, having the world's largest thruput.

Petrochemical-Refining Expansion On West Gulf Coast Unprecedented

HARRIS McASHAN, President
South Texas National Bank of Houston

THE petrochemical and refining industries in Texas and Louisiana reported unprecedented expansion programs costing $887,553,057 during 1951. The petrochemical industry, which started from scratch in 1940 and built up a $1 billion-plus plant investment by the start of 1951, has under way or projected a $648,195,386 expansion. The refining industry has scheduled $239,357,671 in new plant facilities for the two states, with $201,770,671 of the total concentrated in Texas.

The Texas Gulf Coast region—the area from Brownsville, Texas, to Lake Charles, La., extending roughly 100 miles inland—will feel the major impact of new construction. This area will receive $504,575,432 of the petrochemical investment, and $165,365,260 of the refinery construction. Table 1 gives the complete breakdown of dollar totals of the complete program.

TABLE 1
Summary of Construction Totals 1951 Chemical Plants and Refineries Texas and Louisiana

	Chemical Plants	Refineries and Gasoline Plants	Totals
Texas Gulf Coast	$504,575,432	$165,365,260	$669,940,692
Elsewhere in Texas	44,567,146	36,405,411	80,972,557
Texas Totals	$549,142,578	$201,770,671	$750,913,249
Louisiana	$ 99,052,808	$ 37,587,000	$136,639,808
Grand Totals	$648,195,386	$239,357,671	$887,553,057

Tables 2-6 give the itemized program, most of which is based on DPA certificates of necessity. Table 2 includes several chemical projects which have been announced but for which certificates have not yet been issued, but it does not include a number of items for which certificates have been issued but dollar totals have not been disclosed. The table does not include a dollar figure for the substantial expansion program planned for the Humble Oil & Refining Company refinery at Baytown. Neither table includes projects in the chemical category not based on petrochemicals, involving well over $200 million for facilities to produce such items as chlorine, caustic soda, sulfuric acid, etc.

Texas City Project

No other section of the nation comes anywhere near matching the progress being made in petrochemicals in the Gulf Coast region. The largest expansion program was announced by Carbide & Carbon Chemicals Division of Union

TABLE 2

Petrochemical Plants—Expansion Projects—1951
Texas Gulf Coast*

NAME	Location of Facility	Cost	Product
American Petrochemical Corporation	Lake Charles	$20,000,000	Ethylene, other petrochemicals
Carbide and Carbon Chemicals Division	Texas City area	60,285,000	Not disclosed
Carbide and Carbon Chemicals Division	"Texas"	73,663,000	Not disclosed
Celanese Corporation	Bishop	3,485,535	Triozane paraformaldehyde
Celanese Corporation	Clarkwood	500,000	Laboratory
Crown Central Petroleum Corp.	Houston	265,000	Ethylene, propane-propylene
Davison Chemical Corporation	Lake Charles	5,459,750	Petroleum cracking catalyst
Dow Chemical Company	Freeport	3,141,000	Chlorine-caustic
Dow Chemical Company	Freeport	1,061,000	Pipe line for petroleum gases
Dow Chemical Company	Freeport	34,619,000	Chlorine-caustic
Dow Chemical Company	Freeport	5,600,000	Ethylene
Dow Chemical Company	Freeport	1,610,000	Styrene
Dow Chemical Company	Freeport	4,475,000	Hydrochloric acid
Dow Chemical Company	Freeport	3,535,000	Hydrochloric acid
Dow Chemical Company	Freeport	640,630	Power for magnesium production
Dow Chemical Company	Freeport	11,500,000	Power and steam facilities
Dow Chemical Company	Freeport	62,100	Methyl chloride
Dow Chemical Company	Freeport	4,316,800	Ammonia
Ethyl-Dow Chemical Company	Freeport	8,185,000	Ethylene dibromide
E. I. du Pont de Nemours & Company	Beaumont	Not disclosed	Not disclosed
E. I. du Pont de Nemours & Company	Orange	Not disclosed	Nylon intermediates
E. I. du Pont de Nemours & Company	Houston	Not disclosed	Fungicides
E. I. du Pont de Nemours & Company	Victoria	Not disclosed	Nylon intermediates
Eastern States Petroleum Company	Houston,	3,300,000	Benzene
Ethyl Corporation	Houston	44,135,000	Anti-knock compound
B. F. Goodrich Chemical Company	Port Neches	5,350,000	Cold rubber
Goodyear Synthetic Rubber Company	Houston	500,000	Cold rubber
Great Southern Chemical Company	Corpus Christi	4,000,000	Chemical grade benzene
Gulf Oil Corporation	Port Arthur	18,485,342	Aviation gasoline, butylenes, ethylene
Gulf Oil Corporation	Port Arthur	704,756	Isooctyl alcohols
Gulf Oil Corporation	Port Arthur	2,318,855	Sulphuric acid
Gulf Oil Corporation	Port Arthur	586,390	Sulfur
Gulf Oil Corporation	Port Arthur	15,427,000	Ethylene
Heyden Chemical Company	Houston	12,000,000	Methanol
J. M. Huber Corporation	Baytown	2,211,242	Carbon black
Humble Oil & Refining Company	Baytown	177,845	Alkylate
Humble Oil & Refining Company	Baytown	64,941	Toluene, xylene
Jefferson Chemical Company	Port Neches	1,000,000	Ethanolomines
Kolker Chemical Works	Houston	500,000	Insecticides
Koppers Company	Port Arthur	4,475,355	Ethylbenzene
Mathieson Chemical Corporation	Lake Charles	2,266,891	Anhydrous ammonia
Mathieson Chemical Cporation	Lake Charles	2,150,000	Hydrazine
Monsanto Chemical Company	Texas City	25,633,000	Acrylonitrile, hydrogen cyanide
Monsanto Chemical Company	Texas City	8,600,000	Styrene
Monsanto Chemical Company	Texas City	7,340,000	Vinyl chloride
Neches Butane Company	Port Neches	5,000,000	Synthetic rubber
Pan American Refining Company	Texas City	1,100,000	Benzene, toluene
Phillips Chemical Company	Houston	38,260,000	Anhydrous ammonia, methanol, acetylene
Phillips Chemical Company	Houston	3,500,000	Pyridines
Pure Oil Company	Nederland	11,140,000	Butenes
Rohm and Haas	Houston	4,000,000	Acetone cyanhydrin
Sheffield Steel Company	Houston	3,000,000	Coal chemicals
Shell Chemical Corporation	Houston	500,000	Sulfur
Shell Chemical Corporation	Houston	15,500,000	Glycerine, vinylchloride, ethyl chloride, epon resins
Shell Oil Company	Houston	10,400,000	Benzene
Taylor Refining Company	Corpus Christi	3,755,000	Benzene toluene
United Carbon Company	Lake Charles	2,290,000	Carbon black
United States Rubber Company	Port Neches	2,500,000	Synthetic rubber

* The area from Brownsville, Texas, to Lake Charles, Louisiana, extending approximately 100 miles inland.

TABLE 3

Refineries and Gasoline Plants—Expansion Projects—1951
Texas Gulf Coast

NAME	Location of Facility	Cost	Product
Cities Service Refining Corporation	Lake Charles	$26,650,000	Aviation gasoline
Humble Oil & Refining Company	Baytown	110,000	Aviation gasoline
Humble Oil & Refining Company	Baytown	460,000	Aviation gasoline
Humble Oil & Refining Company	Conroe	84,176	Propane
Humble Oil & Refining Company	Baytown	Not disclosed	Expansion of all refining facilities
Maritime Oil Company	Houston	90,000	Aviation gasoline
Ohio Oil Company	Matagorda County	4,108,414	Natural gas, propane
Pan American Refining Company	Texas City	959,662	Gasoline
Pan American Refining Company	Texas City	18,674,500	Gasoline
Phillips Petroleum Company	Sweeny	8,417,000	Aviation gasoline
Phillips Petroleum Company	Brazoria County	6,094,710	Natural gasoline
Phillips Petroleum Company	Sweeny	18,629,000	Motor fuel
Pontiac Refining Company	Corpus Christi	135,000	Storage of petroleum
Pontiac Refining Company	Corpus Christi	475,000	Gas oil
Pontiac Refining Company	Corpus Christi	2,000,000	Aviation gasoline
Pontiac Refining Company	Corpus Christi	275,000	Motor fuel
Republic Oil Refining Company	Texas City	7,000,000	Petroleum products
Sinclair Refining Company	Houston	28,000,000	Petroleum products
Southwestern Oil & Refining Co.	Corpus Christi	3,520,000	Distillate fuel oil
Standard Oil Company of Texas	Houston	1,280,000	Natural gasoline
Sunray Oil Corporation	Corpus Christi	16,120,000	Aviation gasoline
The Texas Company	Port Arthur	19,290,000	Petroleum products

TABLE 4

Petrochemical Plants—Expansion Projects—1951
Elsewhere in Texas

NAME	Location of Facility	Cost	Product
Celanese Corporation	Pampa	10,000,000	Fibers, plastics
Cosden Petroleum Corporation	Big Spring	2,950,000	Benzene
General Atlas Carbon Company	Big Spring	1,545,050	Carbon black
General Atlas Carbon Company	Pampa	152,181	Carbon black
Phillips Chemical Company	Borger	4,668,999	Carbon black
Phillips Chemical Company	Ector County	1,741,000	Sulfur
Phillips Chemical Company	Crane County	510,200	Sulfur
Phillips Petroleum Company	Borger	98,725	Diisopropyl alkylate
Premier Oil Refining Company	Fort Worth	3,000,000	Benzene
Reilly Tar and Chemical Company	Daingerfield	3,000,000	Coal chemicals
Sid Richardson Carbon Company	Fort Worth	2,000,661	Carbon black
Sid Richardson Carbon Company	Odessa	130,830	Sulfur
Shamrock Oil and Gas Company	Sunray	195,500	Sulfur
Skelly Oil Company	Longview	3,000,000	Benzene
Texas Eastman Company	Longview	11,574,000	Butyraldehyde, ethyl alcohol

Carbide & Carbon Corporation, with $60,285,000 earmarked for Texas City and $73,663,000 for new facilities in an unnamed location on the coast.

Dow Chemical Company's program at Freeport is continuing apace, with $78,745,530 already certified. In addition, DPA has certified several other projects for which dollar value has not been assigned. Production facilities for the company's entire range of products are being expanded. Phillips Chemical Company has two projects for Houston—$38,260,000 for a plant to produce anhydrous ammonia and methanol, and $3,500,000 for a facility to make pyridines.

E. I. du Pont de Nemours & Company has purchased 562 acres at Beaumont for facilities to produce an as-yet-unnamed product, is expanding its plants at Houston, Victoria and Orange, but has made no announcements of dollar values. Indications are that a substantial project will be forthcoming at Beaumont. The Victoria plant went on stream in 1951, producing adiponitrile.

American Petrochemicals Corporation—a joint project of Firestone Tire & Rubber Company and Cities Service Oil Corporation—announced it intended building facilities at Lake Charles, with Cities Services' refinery there furnishing light petroleum hydrocarbons for feedstock. This plant presumably will cost from $15 to $20 million. Heyden Chemical Corporation selected a site on the Houston ship channel for a $12 million plant to produce methanol. American Cyanamid, which presently is operating in the area as co-owner, with The Texas Company, of Jefferson Chemical Company at Port Neches, picked a New Orleans site for a $47,745,000 nitrogen plant. The Davison Chemical Corporation will build a $5,459,750 plant at Lake Charles to produce a cracking catalyst. Koppers Company started construction of a $4,475,355 ethyl benzene plant at Port Arthur.

The Koppers plant will be supplied its ethylene from the new $15,427,000 unit Gulf Oil Corporation is building at its Port Arthur refinery. Gulf is building a pipe line to supply du Pont's Orange plant, Ethyl Corporation's $44,135,000 anti-knock compound plant at

Houston, and Solvay Process Division's (Allied Chemical & Dye Corporation) facility at Orange, which was announced early in January, 1952. (First unit of this plant will cost $5,000,000, will produce ethylene glycol and ethylene oxide. The company purchased 650 acres adjacent to the du Pont plant. Dollar value of this plant is not included in either of the tables accompanying this article.)

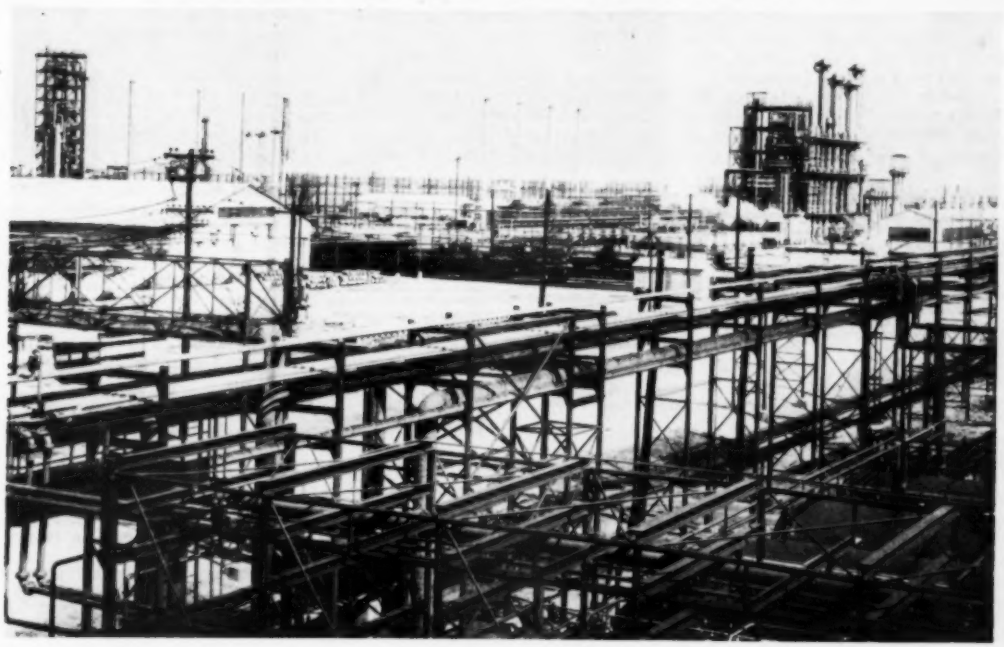
Interchange at Houston

An interesting product interchange has developed at Houston. Sinclair Refining Company has announced a $28,000,000 expansion program at Houston, and will supply the nearby Ethyl plant with a portion of its ethylene requirements. Diamond Alkali Company is expanding its plant at a cost of $7,506,000, including $5,900,000 for additional chlorine-caustic production. (The Diamond figures are not included in the accompanying tables.) Diamond's additional chlorine output will go to Shell Chemical, which in turn is spending $15,500,000 for increased production of glycerine, vinyl chloride and epon resins. Shell will also pipe some of its ethylene to the nearby Ethyl plant. Shell and Diamond are pooling resources to manufacture and market vinyl chloride. Lubrizol Corporation's chemical additives plant went into production in 1951, obtaining part of its feedstocks from Shell Chemical, and in turn selling part of its production to Shell Oil, both plants being nearby.

Ethyl Corporation's tetraethyl lead plant at Baton Rouge, Louisiana, is the largest of its kind in the world.

Shell Chemical expects to put into operation in mid-1952 a $500,000 installation for recovery of 13,000 tons of sulfur annually. Shell Oil has launched

The stacks, towers and overhead piping in this typical petrochemical plant give the Gulf Coast a new skyline.



Recent completion of Continental Oil Black Company's carbon black plant at Westlake, La., will help meet the increased demand for high abrasion furnace black used in synthetic rubbers.

a $10,400,000 expansion for production of benzene and toluene. Of considerable interest during 1951 was Gulf Oil's new $18,485,342 cat cracker which went into production at Port Arthur. (This unit, incidentally, is listed as a chemical plant, because of its output of ethylene and butylenes, in addition to aviation gasoline. Chemical engineers make out a pretty good case for this listing. But, we don't want to start an argument!)

Celanese Corporation is adding $3,485,525 in new facilities at its Bishop plant, $500,000 for a new laboratory at Clarkwood, and will spend an estimated $10,000,000 for a new plant at Pampa to turn out intermediates for fibers and plastics. Monsanto Chemical Company at Texas City has earmarked $8,600,000 for additional styrene production, $25,633,000 for new facilities to produce acrylonitrile, and $7,340,000 for a vinyl chloride unit. Rohm & Haas has a $4,000,000 expansion under way at Houston for additional cyanhydrin output. Texas Eastman Company's $11,574,000 installation at Longview has gone on stream, producing n-butyraldehyde and isobutyraldehyde. Commercial Solvents Corporation has a $20,458,000 program for ammonia and methanol facilities at Sterlington, La., and at year's end received a $1,326,100 certificate for facilities to produce nitrogen solutions. Mathieson Chemical Corporation at Lake Charles is engaged in a $2,266,891 expansion of anhydrous ammonia production, and at year's end received a $2,150,000 certificate for hydrazine-producing facilities at Houston.

Versatility of Industry

(It is interesting to note that ammonia is being produced in the area from natural gas and air, as well as from the process of chlorine-caustic production, the difference being in the source of hydrogen. Thus, one plant producing ammonia may properly be classified as a petrochemical plant, while another facility, producing the same product, may not be so classified. Here again, we don't propose starting an argument. It merely illustrates the growing versatility of the petrochemical industry.)

The accompanying table shows other expansions and new projects covering a wide range of products. One of the more interesting aspects of the current expansion program is that involving units at refineries to produce benzene and toluene, which are in critically short supply. Petroleum has now become an important producer of these materials, which until recent times, derived only from coal. A total of $44,890,000 is involved in benzene-toluene units at refineries in the two-state area. Another development of interest, in addition to the substantial expansion of refining facilities, is the construction of units to recover sulphur both from refineries and from natural gas.

There appears to be no letup in interest in this area on the part of chemical producers. Substantial developments are confidently expected during 1952.

TABLE 5

Refineries and Gasoline Plants—Expansion Projects—1951
Elsewhere in Texas

NAME	Location of Facility	Cost	Product
Cosden Petroleum Corporation	Big Spring	270,000	Gasoline
Great Northern Oil Company	Dallas	6,075,000	Gasoline
Levelland Refining Company	Levelland	2,441,763	Gasoline
Panoma Corporation	Carson County	1,022,650	Aviation gasoline
Phillips Petroleum Company	Borger	4,056,575	Gasoline
Phillips Petroleum Company	Sherman County	6,014,416	Natural gasoline
Phillips Petroleum Company	Hutchinson County	206,830	Aviation gasoline
Phillips Petroleum Company	Sherman County	212,090	Natural gasoline
Phillips Petroleum Company	Crane, Etor, Hutchinson and Moore counties	1,541,940	Natural gasoline
Phillips Petroleum Company	Hutchinson, Moore, Gray counties	78,800	Natural gasoline
Phillips Petroleum Company	Gray and Etor counties	1,201,268	Gasoline
Sunray Oil Corporation	Scurry County	7,654,460	Gasoline
Texas Gas Products Corporation	Upton, Midland, Reagan and Glasscock counties	4,052,000	Aviation gasoline
Texas Natural Gasoline Company	Jones and Fisher counties	1,132,700	Natural gasoline
Warren Petroleum Corporation	Holliday	389,819	Gasoline
Warren Petroleum Corporation	Breckenridge	55,100	Butane

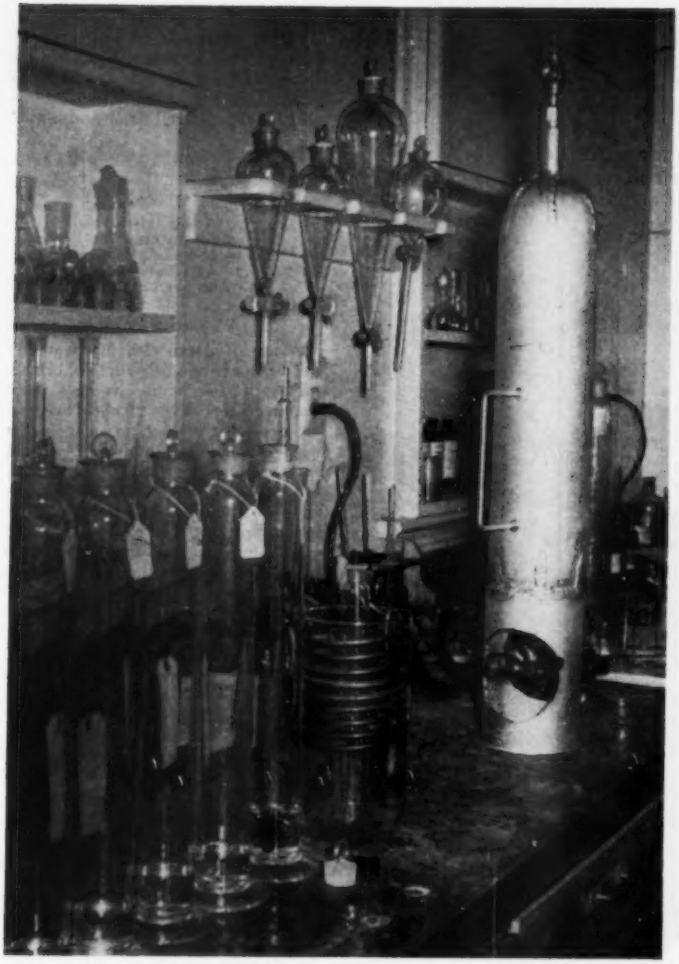
TABLE 6

Petrochemical Plants—Expansion Projects—1951
Louisiana

NAME	Location of Facility	Cost	Product
American Cyanamid Company	New Orleans	$47,745,000	Nitrogen
Aromatics Refining Company	Baton Rouge	11,630,000	Benzene, xylene, toluene concentrates
Atlas Processing Company	Shreveport	2,600,000	Benzene, toluene
Bay Petroleum Corporation	Chalmette	1,726,500	Cracking, catalyst
Cabot Carbon Company	Ville Platte	732,028	Carbon black
Cabot Carbon Company	Bayou Sale	2,174,380	Carbon black
Commercial Solvents Corporation	Sterlington	20,458,000	Ammonia, methanol
Commercial Solvents Corporation	Sterlington	1,326,100	Nitrogen solutions
Continental Oil Black Company	Westlake	1,890,500	Carbon black
Continental Oil Black Company	Westlake	1,514,300	Carbon black
Esso Standard Oil Company	Baton Rouge	3,040,000	Benzene, toluene, butadiene, ethylene, dicyclodienes
Ethyl Corporation	Baton Rouge	4,041,000	Anti-knock compounds
Ethyl Corporation	Baton Rouge	175,000	Anti-knock compounds

Refineries and Gasoline Plants—Expansion Projects, 1951, Louisiana

Acadia Corporation	State	$2,907,000	Gasoline
Pan American Southern Corporation	Destrehan	5,500,000	Gasoline
Shell Oil Corporation	Norco	29,180,000	Gasoline



Special Apparatus Used for Injection of Butane into Jet Fuel Blends.

How Jet Fuel Is Blended to Specifications

B. G. ADAMS

Douglas Oil Company, Bakersfield, California

REFINERS, contemplating the manufacture of jet fuel, will find the experience of one refinery helpful in combining the production of jet fuel and conventional petroleum products. The important specifications for jet fuel are discussed in relation to the particular blending problem faced by a refiner of Southern San Joaquin Valley crude oil.

THOUGH the manufacture of jet propulsion fuel is relatively simple, the production of jet fuel in conjunction with conventional petroleum products presents a special blending problem which must be tailored to the market requirements of each refinery. A conventional topping plant, capable of topping crude oil with an overhead product or blend of distillate streams having an endpoint of 500° F., will usually produce a stock fulfilling the specifications. In fact, one author has reported feasible production with a distillate stream having an endpoint as high as 600° F. Since jet fuel stock includes the distillation ranges of light hydrocarbons, naphtha and kerosine, the problem is to determine a jet fuel blend which will fit into the market scheme of these conventional products.

Procedure

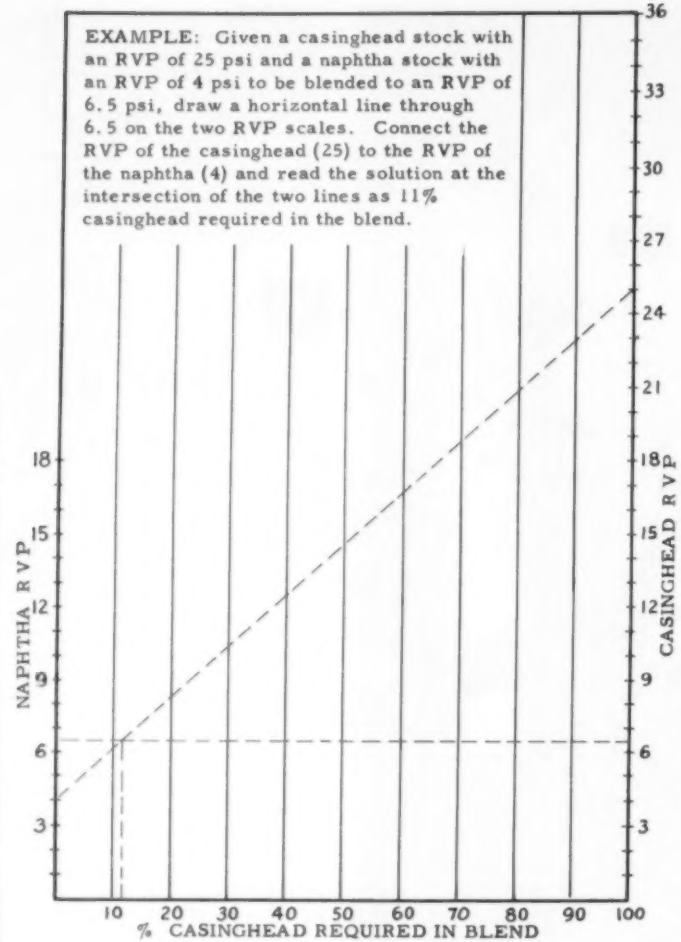
In one refinery, faced with the production of jet fuel and the conventional products from Southern San Joaquin Valley crude oils, the blending proportions were determined by a procedure which considerably simplified the problem. Though the results of the procedure are peculiar to this refinery, the method is of general use.

The first step was to decide upon the relative proportions of distillate streams available for jet fuel blending, while also producing the conventional market products. The following proportions were found to be available for jet fuel blending:

Kerosine distillate (500° F. E.P.)	40-50%
Naphtha cut (300° to 410° F.)	36-46%
Casinghead (22 lb. RVP)	10-20%
n-Butane (56 lb. RVP)	0- 3%

The next step was the preparation of blends to be tested for the critical specifications. The U. S. A. F. specifications for the JP-3 grade of jet propulsion fuel are listed in the table below. (See next page.)

It was anticipated that the specifications of Reid vapor pressure, gravity and freezing point would be controlling, so these specifications were given


EXAMPLE: Given a casinghead stock with an RVP of 25 psi and a naphtha stock with an RVP of 4 psi to be blended to an RVP of 6.5 psi, draw a horizontal line through 6.5 on the two RVP scales. Connect the RVP of the casinghead (25) to the RVP of the naphtha (4) and read the solution at the intersection of the two lines as 11% casinghead required in the blend.
NAPHTHA RVP
CASINGHEAD RVP
% CASINGHEAD REQUIRED IN BLEND
3
6
9
12
15
18
21
24
27
30
33
36
10
20
30
40
50
60
70
80
90
100

Nomograph for Blending to a Given Reid Vapor Pressure.

Jet Propulsion Fuel, JP-3 Grade

Property	Specifications
Reid Vapor Pressure, psi.	5—7
Gravity, °API	45—63
Engler Distillation 90% Evaporated, °F.	400 minimum
Heating Value, B.t.u./lb. net	18,400 minimum
Sulfur, percent	0.50 maximum
Water Tolerance, percent	0.0
Saybolt Color	+12 minimum
Accelerated Gum, mg/100 ml	20 maximum
Air Jet Gum, mg/100 ml	10 maximum
Bromine Number	30 maximum
Aromatics, percent	25 maximum

the initial attention.

With the use of such a large proportion of kerosine in the blend, meeting the Reid vapor pressure minimum was necessarily accomplished by the addition of casinghead gasoline and sometimes butane. Initially, a chart, as illustrated, was prepared correlating the amount of naphtha used with the amount of casinghead required to meet the vapor pressure specification. Where this chart revealed that the amount of casinghead necessary was in excess of its availability, the amount of n-butane required was determined experimentally with the use of special injection equipment shown in the photograph.

The butane sample was collected in a bomb fabricated from three-inch pipe. Cooling the butane to a liquid suitable for injection was accomplished by using a coil and receiver surrounded by an isopropyl alcohol-dry ice bath. With this coil connected to the bomb, the butane could be withdrawn into the receiver at a temperature of —100° F. A precooled pipette was used to withdraw the butane from the receiver and to inject the butane into the jet fuel blend for the subsequent vapor pressure determination.

Gravity

The limitation of 63° API gravity necessitated determinations for the maximum high gravity constituents permissible in the blend. The formula used for this determination follows:

$$\% \text{ High Gravity Material} = \frac{H - D}{(H - D) + (D - L)}$$

where H = API gravity of high gravity material
D = desired API gravity
L = API gravity of low gravity material

Freezing Point

It might be expected that water in the distillate streams would be the controlling factor in the freezing point characteristics of the blends. However, the operating situation is such that water precipitates from the stocks in storage and is of no importance. Hence, for laboratory purposes, it is permissible to filter the stock samples. The controlling factor was found to be the congealing point of the hydrocarbons in the kerosine distillate, so the problem amounts to determining experimentally the maximum amount of kerosine permissible in the blend.

Though the freezing point procedure has been described in detail in the Federal Catalog VV-I-791d (Method 141.1.2), additional information is needed by the inexperienced tester.

As the temperature of the blend descends, crystals appear at approximately —50° F. This point is not the actual freezing point, but represents ice crystals formed from air moisture drawn in by the agitator. Confirmation of this theory is established by removing the jar from the bath. If the crystals remain after the temperature has risen 10° F., then the conclusion is that these crystals are air moisture. The actual freezing point is indicated by the amorphous congealing of hydrocarbons which disappear when the jar is removed from the bath.

Other Tests

In the blending ranges outlined, the 90 percent point, heating value, sulfur content, and water tolerance were well within the specifications in every blend. The kerosine distillate was given sulfuric acid and clay treatment prior to blending, so the color specification was easily met. Since only straight-run distillates were blended, the accelerated gum, air jet gum, bromine number and aromatics content fell within the specifications.

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Shale Oil Production And Refining Today

Part I

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THE U. S. BUREAU of Mines recently announced that it will build a much larger plant for the production and refining of shale oil. This project, together with the recent dangerous developments in Iran, has again placed the subject of shale oil in the limelight. The amount of crude oil available from U. S. shales is tremendous, and has been estimated in excess of 225 billion barrels.

Many new processes are under consideration for recovering oil from shales, including adaptations of the fluidized solids and TCC techniques. In most instances, the ultimate objective in refining shale oil is the manufacture of a marketable grade of gasoline or diesel fuel. Yield of "straight-run" oils in the gasoline and diesel oil boiling range is small and must be supplemented by cracking or hydrogenation processes.

Refining operations which have been applied experimentally to shale oil include crude distillation, visbreaking, recycle cracking, coking and reforming. One of the most promising refining schemes for production of maximum gasoline yields starts with hydrogenation of the shale oil. This article begins a three-part series on the various phases of shale oil production and refining.

IN a normal economy, industry will choose the path of least resistance to satisfy a growing demand. The obviously proper solution to the world's insatiable demand for hydrocarbon products rests in the production and refining of petroleum—as long as supplies are readily accessible in adequate amounts.

America's bountiful resources have until recently permitted complete reliance on natural oil as a source of liquid hydrocarbon fuels. Tremendous production rates of the last decades and an ever-expanding market have forced the oil industry to turn to less accessible fields in increasing measure, resulting in rising crude prices.

Thus the economic outlook supports strategic demands that America look to alternate sources of liquid fuels. The first significant step in this direction came with the erection of a synthetic gasoline plant at Brownsville, Texas, where natural gas is converted to liquid hydrocarbons (and byproduct chemicals) by a version of the Fischer-Tropsch gas synthesis process. At this writing, the plant has just been taken on stream, and complete economic figures are not yet available. From all indications, it may be expected, however, that this will be a fully competitive approach to gasoline production.

Liquid Hydrocarbon Demand

The competitive soundness of this process will be dependent on the continuance of adequate outlets for the byproduct oxygenated alcohols—which would vanish after the erection of six or seven 8000-barrels-per-day plants. Moreover, natural gas production in the United States is by no means sufficient to cover more than even a small fraction of the national demand for liquid hydrocarbons.

The search for supplementary hydrocarbon sources must therefore turn to other raw materials. Most important in this picture is coal which can be converted by gasification followed by Fischer-Tropsch synthesis, or by high-pressure hydrogenation (direct liquefaction). These two processes complement each other, being most suitable for different raw materials and products. The economic picture for these processes is by no means bright at the present time (i.e., for American conditions), but their consideration must be included in any serious study of the country's long-range fuel picture.

Oil Shale Alternative

The third important alternative source for liquid hydrocarbons are the vast deposits of oil shale which abound in the Colorado-Utah-Wyoming area. Estimates place the potential hydrocarbon yield from this source well above that obtainable from known petroleum deposits. However, at the present time the economic situation still minimizes the importance of gasoline production from oil shale, which is not yet the path of least resistance.

The long-range attractions of shale oil production have led to some important studies which have been carried out on a pilot-plant scale in the United States since World War II (e.g. by U. S. Bureau of Mines, Union Oil Company of California, and Esso Standard Oil Company). At this juncture, it is therefore well to take stock of our present knowledge of shale oil production methods, and the problems, difficulties, and potentialities, involved.

Occurrence of Oil Shales

Table 1[1, 2] summarizes the oil shales which have so far been located in the United States. The richest (up to 60 gallons/ton) and most important deposits are concentrated in the Rocky Mountain Area and it is here (at Rifle, Colo.,) that the U. S. Bureau of Mines is operating its 200-barrels-per-day retorting plant. The potential of these shales is immense and it has been estimated that the tertiary oil shales of the Rocky Mountain States, the Devonian black shales of the Central

TABLE 1

Reserves, Millions of Barrels	State	Geology	Seam Thickness	Yield per Ton Shale: Oil, Gal.	Yield per Ton Shale: $(NH_4)_2SO_4$ Lb.	Characteristics	Reserves	Nitrogen Content, Percent
	California	.....	Very thick.	20	.....	Soft, brownish, smells strongly of petroleum when freshly broken.	.....	.....
300,000	Colorado (N.W.)	Green River Formation. Tertiary	Rich oil shale strata from few inches up to 30 feet.	35-60	20	Colour varies from grey to brown, more massive shales dark brown to black.	Payable shale for many years.	.....
3,044	Wyoming (S.W.)	Green River Formation.	20-49 feet	35-60	20	.....	.....	.....
42,800	Utah (N.E.)	Green River Formation.	20-49 feet	35-60	20	.....	.....	.....
6.0	Nevada	Deposits lie in big shallow basins.	4 feet	28	....	Lighter coloured than Green River Formation Shales for same yield of oil.	.....	0.43 ±
	Montana	Phosphoria Formation of of Permian strata.	.....	20		High percentage of phosphates. Dark brown to black, weathered surface bluish-white. Smell of petroleum when freshly broken. Readily combustible. Phosphorus 2% calculated as P_2O_5.	.....	.....
		Tertiary beds instratified with sandstones and lignite.	5 feet	24	.....	Light brown, nearly white on weathered surfaces.	.....	0.9
11,000	Kentucky and Eastern States	Mainly Upper Devonian. Also Lower Devonian Ordovician and Carboniferous.	.....	16	58.6	Black or brown. High percentage of sulphur.	Very large but of poor quality.	.....

States, and the cannel shales of the Central Eastern States represent a combined recoverable production of about 224 billion barrels crude oil.[3] This is enough to cover the United States oil consumption (at its present rate) for some 100-120 years.

In this connection, it is worth noting that the United States has once before had a shale oil industry—prior to the discovery of petroleum in Pennsylvania. At that time, some 60 shale retorting plants operated in the Eastern United States.[1] These installations were naturally very small and of simplest design, and were forced to operate with the low-grade shales available locally. Oil recovery was only 8 to 20 gallons per ton.

Aside from this nineteenth-century industry, America's interest in the exploitation of oil shales is of comparatively recent origin (except for some sporadic efforts by the U. S. Bureau of Mines during the twenties). Other countries, less richly blessed with petroleum resources have long since built important industries around their own shale deposits. Particular significance attaches in this connection to the shale oil industries of Estonia, Scotland, and Manchuria.

Industry in Estonia

The most important European oil shale industry is located in Estonia, based on the locally abounding "kukersite" shale which yields 48 to 86 gallons per ton. This industry reached a prewar peak production of 750,000 tons shale mined in 1936. Under German occupation, this output was raised to 1,700,000 tons and retorting plants were erected for the 1944 target production of 1,653,000 tons shale oil per year. Cadman[1] reports that three new refineries have been constructed since that time. They are said to be connected to Leningrad by pipe line in order to supply that city with gas from Estonian oil shale works.

Operations on a much smaller scale (200,000 barrels per year shale oil in 1942) are carried on in Sweden which possesses large shale deposits of low (12 gallons per ton) oil content.

French shale deposits, averaging 11 to 24 gallons per ton, are being exploited on a relatively small scale. Probably the most important installation is at Autun where shale is distilled at the rate of 840 tons per day.

Scotland's 100-year old oil shale industry has been declining steadily since its peak production of 3,280,143 long tons in 1913. In 1946, only 1.33 million long tons oil shale were mined. Average yield is 24 to 30 gallons oil per ton. Bell[2] points out that the quality of Scotch oil shale has declined throughout the industry's life. The most important developed deposits are located in the Lothians of Scotland.

English Shale Deposits

Probably the most extensive English oil shale deposits are located in Dorset and Norfolk. These minerals are rich in organic matter (40-70 gallons per ton) and have been used locally as solid fuel. Main obstacle to the commercial exploitation of these shales is their very high sulfur content which rises as high as six percent in some deposits.

Large deposits of low-grade oil shale (4.5 weight percent) have been located in Württemberg, in the American zone of Germany. Commercial production in these fields is negligible and the existing pilot plant installations are chiefly significant for the technical information which has become available from their operation.

At least one commercial shale oil distillation plant has been erected in Spain. Basis of operation are the Puerto Llano deposits which assay 27 gallons crude oil per ton and which offer particularly rich byproduct ammonium sulfate recovery (22 pounds per ton).

Other significant European oil shale deposits are found in Sicily, Czechoslovakia, Turkey, Bulgaria, and Portugal. No industrial recovery has been reported for any of these countries.

Immense oil shale deposits, estimated at 55 billion metric tons, are located in Russia, notably along the Volga and in Leningrad Oblast. With a recoverable oil content of 40-50 gallons per ton, these deposits are the basis for an industry which retorted 700,000 tons in 1936.[3] Since that time, this industry has undergone expansion. Target shale capacity for 1942 was four million tons.

Probably the most important shale oil production so far achieved is reported for the Manchurian Fushun fields where shale oil was reportedly produced at the rate of 3.5 million barrels per year in 1945. The shales are comparatively low-grade, assaying not more than 15 gallons per ton. The significance of this industry is to be ascribed chiefly to Japan's complete lack of indigenous petroleum resources and the small extent of her synthetic oil industry which led her to exploit Manchuria's inferior oil shale deposits during the war.

Particularly rich oil shale deposits (up to 100 gallons per ton) have been found in South Africa as well as in Brazil. Other potentially valuable beds are located in India, Canada, Australia, Tasmania, and New Zealand. Australia's rich torbanite was retorted to the extent of 250,000 barrels of oil in 1947. A small industry has been built up on the basis of Tasmania's deposits but this is severely limited by the low yields (18 gallons per ton) and the high sulfur and nitrogen content of the indigenous shales.

Mining American Oil Shale

One of the most important economic items in shale oil production is the mining cost of the raw material. While this subject is outside the proper scope of the present paper, its important effect on the eventual success of the entire shale oil industry warrants a brief discussion of major methods under consideration.

Only the relatively insignificant Eastern United States deposits are located under a small enough bed of overburden to permit open-cut mining methods. Cost advantage over underground mining methods is appreciable enough to permit economical exploitation of lower-grade deposits, and this method is indeed being employed for the excavation of lean ores in Sweden, the Fushun district of Manchuria, and in some sections of Estonia. An important drawback of beds which are susceptible to strip-mining is the much more advanced degree of weathering with all its deleterious effects on oil quality and yield which will be discussed below.

The usual strip-mining techniques are applied. Overburden is removed by means of bulldozers, power shovels, and dragline excavators, and is removed from the excavation by truck, carrier belt, etc. The exposed shale is loosened in situ by blasting and is collected by stripping shovels. Open-cut mining costs are estimated at $0.25 per ton of material handled.

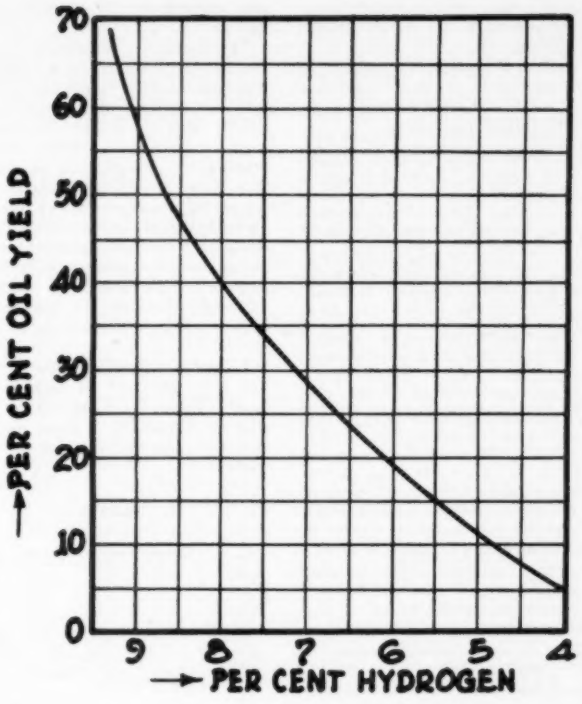

Figure 1. Effect of Hydrogen Content on Oil Yield.

Rocky Mountain Beds

More important, because of the nature and extent of the deposits, are the oil shale beds in the Rocky Mountains. Here, open-cut mining methods cannot be employed and resort must be had to underground mining. Important progress has been made in this connection by intensive studies carried on by the U. S. Bureau of Mines in an experimental 200-ton per day mine at Rifle, Colorado. Gardner and Siprelle[4] report that mining costs of 50 cents per ton have been demonstrated, considerably below the anticipated costs. Including crushing and conveying to the retorting plant, over-all shale production costs are estimated at 55.4 cents per ton in a commercial operation.[5]

The proposed mining operation is the room-and-pillar method in which large rooms are excavated underground, leaving pillars of shale for support. Rooms and pillars are rectangular and laid out with almost mathematical care. Permissible room width depends on the strength of the ore and is of signal influence on mining costs. Room widths of 80 feet have been tested and found to be completely satisfactory. Of particular importance is the development of a new hard-surfaced rock bit for drilling over 70 feet in oil shale before resharpening becomes necessary. Other mining problems have been solved to the satisfaction of the Bureau's engineers. For a more complete discussion of oil shale mining methods, the interested reader is referred to Bell's book on the subject.[2]

It is interesting to note that European studies on oil shale recovery have included the underground pyrolysis of low-grade beds.[6] Processes of this type —like underground gasification of coal—permit only limited recovery of the oil. At the experimental installation at Schorzingen (Germany), oil recovery was some 30 percent of the Fischer assay—the standard method of determining the oil content of bituminous shale. Underground pyrolysis methods are of potential interest only where they promise considerable savings in labor charges. Highly mechanized American mining methods are believed to close the door to any economic benefit from this type of approach to oil shale exploitation in this country.

Classification of Oil Shales

Oil shales and cannel coals belong to a wide group of fossil materials which, upon heating to temperatures above 750° F. decompose with the formation of varying amounts of oil, gas, and solid residue. In point of order, oil shales take a position intermediate between the other main classes of naturally-occurring materials from which oil can be obtained by heat treatment: 1) Oil Sands,* Tar Sands, Bituminous Limestones, and 2) Coals ranging from peat to anthracite.

The progression of minerals from oil sands to anthracite is fairly continuous and lines of demarcation must be drawn by arbitrary definition. Thus, both oil sands and oil shales are characterized by the presence of very large amounts of mineral matter in association with the oil-yielding organic matter. The important distinction rests in the large solubility of the organic matter of oil sands in normal petroleum solvents. By contrast, little organic matter can be extracted from oil shale by solvents at room temperature and pressure. The series ascending into the

* Note that oil can be recovered from oil sands by water-washing.

group of coals yields a progressively smaller portion of the organic matter as distillable oil.

A system of classification which has been proposed by Down & Himus[7] and which has found wide acceptance defines the following groups:

Oil Shales (or "kerogen rocks"): Sedimentary rocks containing organic matter which, on distillation, yields an oil, equivalent to approximately 50 percent of the organic content. Occur in continuous seams, covering considerable areas. Generally not associated with coal.

Cannel Coals (or "kerogen coals"): Carbonaceous materials in which the organic matter preponderates, occurring in lenticular patches over very limited areas. Often associated with bituminous coals, with which they may form compound seams or into which they may grade either vertically or laterally.

Coals: Accumulations of fossilized plant debris, forming seams covering considerable areas, associated with relatively small amounts of mineral matter. On distillation, yield about 10 percent of the organic matter as oil.

In point of fact, the term "oil shale" is a misnomer since no oil is present as such in the raw material. Rather the oil is formed as a cracking product of the original organic matter to which the term "kerogen" (i.e. "oil-former") is applied. Hence the terms "kerogen rock" and "kerogen coal" which Down prefers to the classical terms "oil shale" and "cannel coal" and which have of late been used with increasing frequency in the literature on the subject.

Some Properties of Oil Shales

From a practical point of view, the most important properties of oil shales are oil yield and nature of the distillate. Greatest significance thus attaches to the organic, or "kerogen" portion of the rock which constitutes the parent material for the oils formed in the course of thermal breakdown.

For the purpose of identifying the chemical nature of the original kerogen, separation from the associated mineral matter is necessary, without affecting the organic components. Partial success can be achieved in this objective by decomposing the rock components by means of mineral acids (HCl, HF, H_2SO_4). This approach permits reduction of the ash content to as little as 0.9 percent. Guthrie[8] reports that this method is not directly applicable to the isolation of kerogen from shales yielding more than 15 gallons per ton. In such instances, wetting must be promoted by pretreating the rock with eighty percent alcohol. There is evidence that these chemical methods of separation result in partial reaction of the organic matter, however, and Luts[9] recommends separation by flotation in a calcium chloride solution. Ash content of an Estonia shale was reduced to 3-8 percent in this manner.

The chemical constitution of kerogen has been studied by a number of investigators. Downs and Himus[10] find that the nature of kerogen varies widely with its origin. Structure of some kerogens is reported to resemble broadly the constitution of coal in that there is definite evidence of a benzenoid structure. Other kerogens (notably that of the Estonia algal limestone) differs in constitution from coal in that there is no evidence of benzenoid structure. Still other types (Scottish, Amherst) combine the presence of both non-benzenoid and benzenoid materials.

Ultimate analysis of some kerogens has been reported by Guthrie[8] and Luts[9] (Table A.) It should be noted that the H-content of these materials exceeds considerably that of most coals.

TABLE A

	Kentucky[8]	Colorado[8]	Australia[8]	Estonia[9]
Carbon	75.70	78.40	81.20	76.5–76.8
Hydrogen	8.00	10.42	10.20	9.1– 9.3
Sulfur	2.20	1.20	1.65	1.7– 2.2
Nitrogen	2.12	2.58	.80	0.2– 0.5
Oxygen plus Ash	12.08	7.40	1.15	10.5–11.9

(Note that methods of isolation employed by Luts and by Guthrie differed as outlined above.)

Exposure to air and ground water has a far-reaching weathering effect on the composition of both kerogen and the associated mineral matter. While there is evidence that the primary shale deposit in any given region is fairly uniform, there have been considerable local changes due to such external influences, and care must be exercised in the selection of the sample and in the conclusions drawn from any one set of analyses.

Retorting a Cracking Process

A prime result of weathering is decreased hydrogen content of the organic matter. Oil shale retorting is, above all, a cracking process in which the hydrogen/carbon ratio is disproportionated. A decrease in hydrogen content therefore permits the formation of only smaller amounts of hydrogen-rich volatile oils and the distillate yield is therefore decreased. A normal shale, with an ash content of 40-60 percent, may be expected to yield oil amounting to 65-66 percent of the total organic content, when distilled in a standard Fischer laboratory retort. Figure 1 illustrates strikingly how oil recovery of Estonia kukersite is affected by decreasing hydrogen content of the pure kerogen.[9]

In speaking of the "possible oil yield" of a shale, considerable importance attaches to the exact method by which the assay has been performed. The method of analysis is in itself, a manufacturing operation since it is not desired to measure any property originally present but rather the oil yield formed in the course of distillation which is subject to wide variations as a function of operating conditions. Almost universally employed today for analytical purposes is some modification of the Fischer aluminum retort, whereby exactly standardized conditions of time, temperature, pressure, and equipment must be observed. The modification being used in the United States has been developed by the U. S. Bureau of Mines and is described in detail in a paper by Stanfield and Frost.[11]

Secondary effects of shale weathering make themselves felt in the composition of the distillate oil. Thus, the phenol content is reduced significantly, the sulfuric acid solubility (a measure of the degree of unsaturation) is lowered, and the specific gravity is decreased.

Effect of Operating Variables

Important in the design of optimum commercial retorting conditions, is a knowledge of the effect of operating variables on oil yield. Guthrie has shown that slow retorting will result in a lowered oil yield but in an improved product as regards amount of light distillate, percentage of unsaturation, viscosity of vacuum distillation fractions, and carbon residue of the vacuum distillation residuum, when compared to retorting at standard rates (in a Fischer laboratory assay unit). The volume of gas formation was greater in the slow runs.

According to Popham,[12] pressure has a favorable effect on the oil yield from shale. This work is, however, inconclusive and further studies along this line may prove useful. There is, of course, no question that high *hydrogen pressure* is advantageous in shale oil distillation, since it will minimize coke formation. The use of high-pressure hydrogenation as a means of obtaining rich oil yields has been variously proposed and has been studied in some detail by D'yakov.[13] The method is not too promising, however, because of the high cost of hydrogen and the large amounts of mineral matter which must be handled in the process and which will introduce a major economic problem into the residue processing stage of the process.

Below 930° F., the use of steam has a slightly favorable effect on the oil yield; above this point decomposition will set in and losses are incurred.

The particle size (below 1½-inch) of shale being retorted in the labora-

tory (Fischer assay) has been found to have practically no influence on the oil yield obtained.[8] In commercial retorting (e.g. Royster process), a definite, though not very large, decrease in oil yield can be discerned as the particle size increases.

An interesting phenomenon observed with some oil shales is the physical deterioration which ensues upon contact with organic solvents. The breakdown into small particles occurs rapidly, and is especially pronounced in the case of solvents of low surface tension. The phenomenon is probably due to the porous nature of shale which permits the entry of the solvent into capillary openings where it sets up local pressures, high enough to burst the shale.

The low solubility of kerogen in organic solvents below 100° C. has already been mentioned as one of the characteristics of shales. Kogerman[14] has studied this property quantitatively in the case of Estonian kukersite. The only solvent capable of extracting more than one percent of the raw material was carbon tetrachloride which removed 2.2 percent. The extraction was accompanied by physical deterioration of the shale and by the evolution of HCl.

Nature of Shale Oil

Oil produced in the course of primary retorting of kerogen rock is a black, viscous liquid, with a high pour point, a high content of unsaturated hydrocarbons, and a substantial quantity of compounds containing nitrogen and sulfur. The unsaturated character of this oil finds expression in the ultimate analysis which shows a lower hydrogen and higher oxygen content than is observed in corresponding petroleum products. Luts[9] finds that the hydrogen content of a large variety of shale oils is related to the specific gravity (d) by the equation:

$$\% H = 24\text{-}14.3d$$

Comparing this with Cragoe's correlation for petroleum products (% H = 26-15d), it may be estimated that shale oils contain about one percent hydrogen less than petroleum crudes of the same specific gravity.

To a considerable extent, the nature of shale oil depends on the method of retorting as well as on the origin of the shale. Table B[9] shows typical properties reported for an Estonian shale oil produced a) in tunnel retorts, and b) in Pintsch retorts (retorting processes will be discussed in Part II of this series):

TABLE B

	Product of Tunnel Retort	Product of Pintsch Retort
Specific Gravity	.946	.998
Ultimate Analysis:		
Percent C	83.6	83.0
Percent H	10.6	9.7
Percent O	5.2	6.4
Percent S	.55	.9
Heating Value Btu./lb	17,700	17,000
Tar Acids, Percent	22	30

Other properties are similarly a function of shale origin and retorting conditions. Typical are the following values reported by the U. S. Bureau of Mines for an oil obtained in the course of gas-flow retorting of a Colorado shale,[5] Table C.

TABLE C

Crude Oil:	
Gravity, °API	17.3
Viscosity, S.U.S. at 130° F.	228
Viscosity, S.U.S. at 210° F.	58
Pour Point, °F.	80
Flash Point, (C.O.C.) °F.	250
Conradson Carbon, Weight percent	6.0
Sulfur, Weight percent	.7
Nitrogen, Weight percent	2.2
Water, Volume percent	10.2
Sediment, Weight percent	2.0
100 Ml. Distillation (Corr. to 760 mm.):	
I.B.P.	225
2	426
5	463
10	507
20	582
30	616
40	630
50	641
60	651
70	660
O.H. rec., percent	77

Torrey[15] reports that the straight-run gasoline has an octane rating below 60, is high in ring-type sulfur, tar acids, and tar bases. It is, moreover, gum-forming and has poor color stability and is low in light ends. Not much better characteristics are reported for the straight-run Diesel oil fraction. Proper refining methods are thus a major problem in the manufacture of internal combustion fuels from shale oil.

Of particular interest, and potential chemical value is the high phenol content of shale oils. Crude oils assay as high as 40 percent tar acids. Most of the phenols involved are of high molecular weight and partial breakdown occurs in the course of cracking. Recoverable tar acids found in the secondary processing products do not exceed 4 percent.

Nitrogen originally present in the kerogen is partially pyrolized to ammonium sulfate. Most of the remainder is found in the oil in the form of tar bases. The distribution of nitrogen between oil and gas phases depends to a great extent on the method of retorting. Guthrie[8] has shown that slow retorting and high temperatures favor the reduction of tar base formation and tend to convert substantially the entire nitrogen content to ammonium salts. The pressure distillate of nitrogen-rich crude shale oil was found to contain picolines, lutidines, collidines and parvolines. Unsubstituted pyridine was substantially absent.

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End of Part I. Part II (of a three-part series) will appear in an early issue.

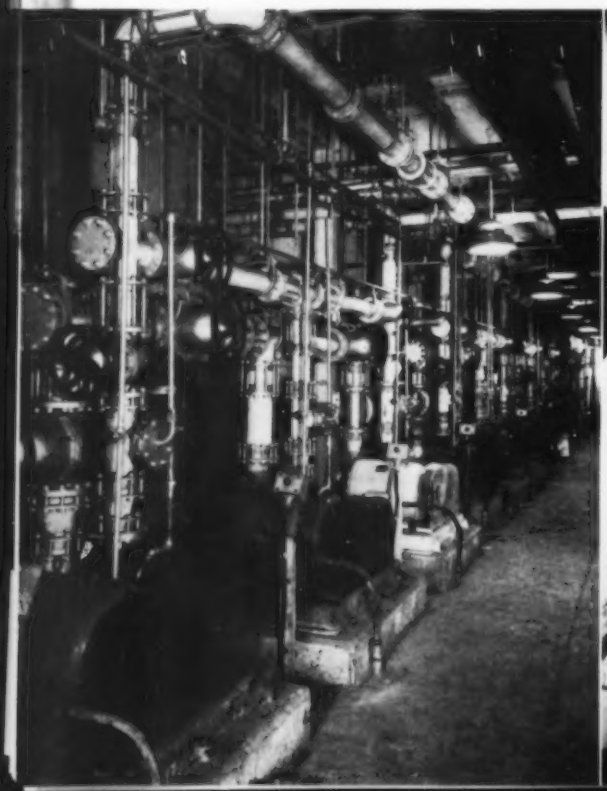
* * *

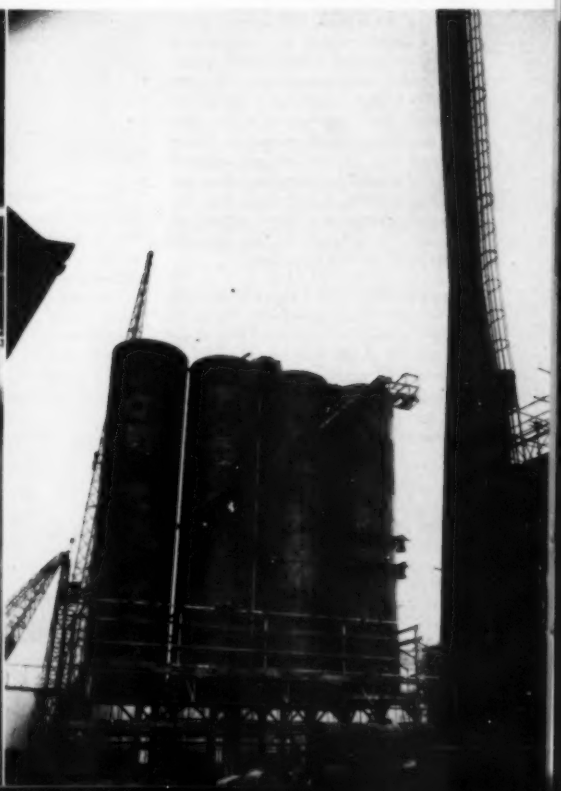
Laboratory facilities insure uniform product quality of the synthetic catalyst.

Synthetic Catalyst Plant Points to Increasing Demand in Europe For High-Octane Gasoline

THE increased demand for high-octane gasoline in Europe is reflected by the completion of a new synthetic catalyst plant in Warrington, Lancashire, England. The new plant, erected at a cost of $2,800,000, will manufacture synthetic catalyst from sodium silicate by a process developed by The Davison Chemical Corporation. The rugged equipment necessary in the process includes two stainless steel dryers, which are the largest dryers of this type to be made. The construction of the plant began in October, 1950, with Taylor, Woodrow Construction Ltd., as the contractors, who built the plant from materials and equipment of British manufacture.

The construction of the plant followed financial agreements between Joseph Crosfield & Sons, Ltd. and The Davison Chemical Corporation and also between Crosfield and several oil companies (Esso Petroleum Company, Ltd., Anglo-Iranian Company, Ltd., Shell Refining & Marketing Company, Ltd., Trinidad Leaseholds Ltd., Bahrein Petroleum Company Ltd.). The plant will be operated by Joseph Crosfield & Sons, Ltd.

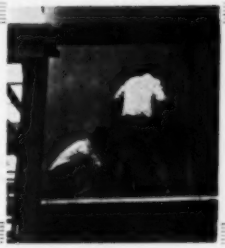


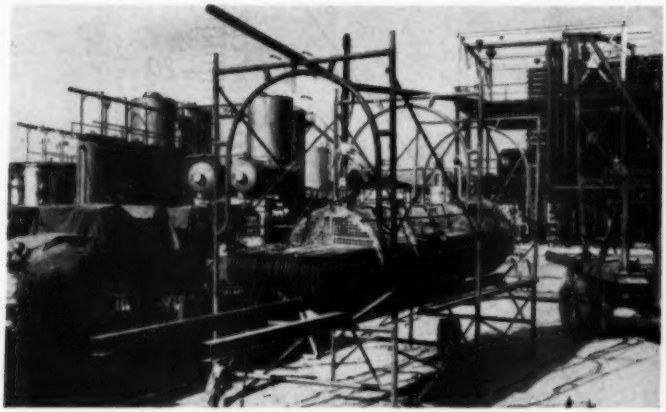


Left—Slurry transfer pumps are an integral part of the equipment.

Right—Finished product silos and secondary dryer stack near completion.

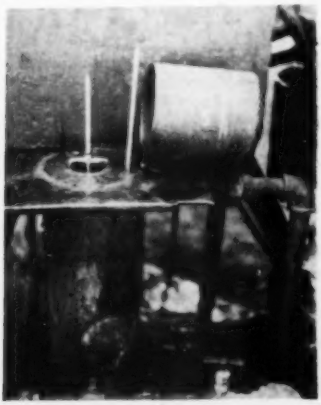
MAINTENANCE And OPERATION How To Do It—





Supports for Tube Bundles

INSTEAD of repairing tube bundles on a work bench, the maintenance foreman improvised a bundle support by erecting three sections of construction scaffolding. These scaffold sections are normally used in erecting processing equipment and in insulating columns. Each supporting member is similar so that stacking is accomplished by inserting the top end of a vertical member into the expanded end of the next member. To make the bundle support, three sections were erected in series and braced with diagonal rods. Two rails or I-beams placed horizontal on the transverse members of the sections form a foundation for the tube bundle. Chain hoists attached to the top horizontal members of the sections provide a means of lifting and turning the bundle while it is being retubed.



Gravity Determinations

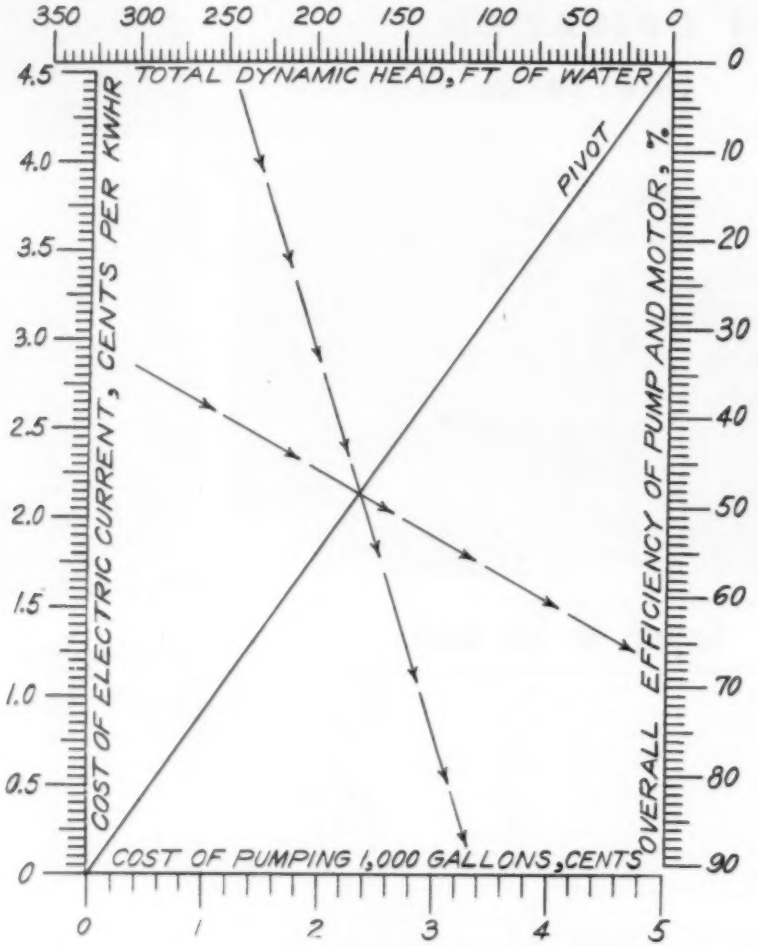
GRAVITY determinations on viscous samples can be facilitated by the permanent installation of a steam-jacketed hydrometer case pictured here. A closed-end cylinder of two-inch pipe was jacketed with six-inch pipe as a steam chest. A steam connection to the jacket enables the operator to heat the sample to the desired temperature. The sample to be tested is poured into the cylinder and steam is admitted to the jacket. Temperature indications are obtained from thermometers in the jacket and in the sample. The use of a metal cover protects the thermometers and hydrometer from breakage.

Sampling Device for Volatile Liquids

SAMPLING butane, propane and like volatile hydrocarbons has been simplified at one plant by use of the sample device illustrated. The sample container, heart shaped in form, is fabricated from a swage nipple tapering to a quarter inch at one end and three-quarter inch at the other. A half-inch nipple, welded to the body tangentially, causes the liquid released from the line to follow a swirling path, which rapidly lowers the inside temperature to a point approximating the boiling point of the liquid. As soon as the instrument frosts over, only a trace of vapor is noticed and the container may be filled completely for analysis in the laboratory.

Maintenance and Operation Ideas Are Worth Money. Send your HOW TO DO IT suggestions with photos or sketches to Editor, Petroleum Refiner, Box 2608, Houston, Texas.

Nomograph for Pumping Costs



A MAJOR factor governing many engineering decisions is the cost of doing a certain job. This fact is often met in petroleum-plant design and operation, especially when considering the pumping of fluids. Computation of pumping costs can be tedious, particularly when several different pipe sizes are being considered. This chart simplifies pumping-cost calculations and permits several to be made in the same time needed for one longhand calculation. Here's how it's used.

Example: A pump with an efficiency of 80 percent is driven by a motor with an efficiency of 85 percent. What is the cost of pumping 1,000 gallons of water when electricity costs three cents per kwhr and total dynamic head on pump is 250 feet?

Solution: Over-all efficiency of pump and motor is (80 percent) (85 percent) = 68 percent. Enter the chart at the left and from three cents per kwhr on the current-cost scale draw a straight line through 68 percent over-all efficiency on the right-hand scale. Then, from 250-feet dynamic head on the upper scale draw a straight line through the intersection of the first line with the pivot line. On the bottom scale read 3.4 cents, cost of pumping 1000 gallons of water.

Note that pump capacity need not be known to use this chart. Where fluids other than water are pumped, (oil, gasoline, benzene, etc.), simply multiply the cost found from the chart by the specific gravity of the fluid.

Example: What would pumping cost be if oil with a specific gravity of 0.85 were handled under the same conditions as in the above problem?

Solution: Solve as before. Then cost = 3.4 (0.85 = 2.89 cents per 1000 gallons pumped.

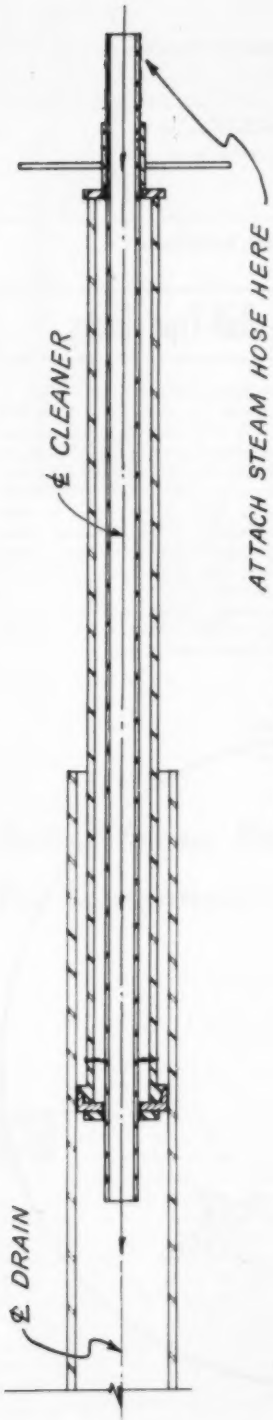
Total dynamic head given on this chart covers the range most often met in petroleum-plant pumping jobs.

This nomograph was prepared by T. G. Hicks, Hicksville, N. Y.

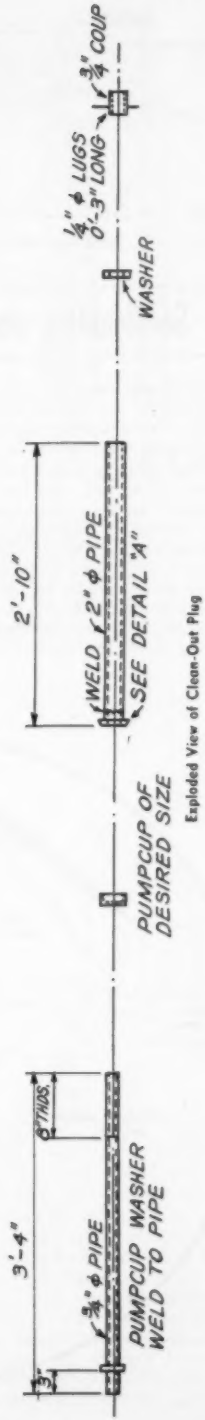
Blowing Out Plugged Lines

WHERE a line resists unplugging through the use of an ordinary hose, a possible solution may be found with the use of the clean-out plug shown in the accompanying sketches. The plug was constructed from scrap materials and has been found to work so well that the mechanic made a plug for each pipe size up to 6 inches for use in the plant. In use, the plug is placed in the line by tightening the jam coupling. The tapered plug is thereby forced against the inside of the leather cup, which expands tightly against the wall of the drain. Steam is then connected to the threaded end of the plug and the pressure is applied through the hose. The tool is readily adaptable to steam, air or water pressure, having been designed for pressures up to 150 psi.

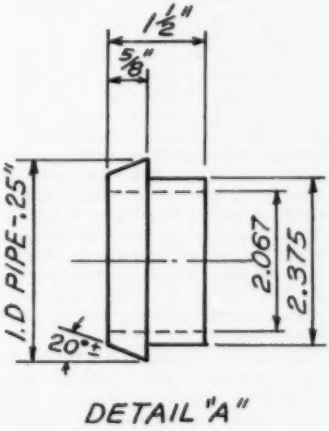
—Honorable Mention, Class D, Tom Siefkes, Shamrock Oil and Gas Corporation, Sunray, Texas.



Assembled View of Clean-Out Plug



Exploded View of Clean-Out Plug



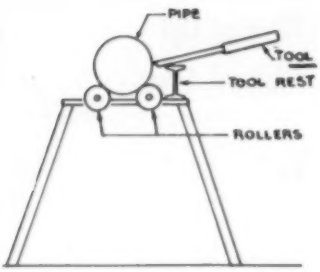
DETAIL "A"

NOTE

The maintenance and operation hints on this and the following page are the prize winning "Operation Kinks" from the Panhandle-Plains Regional Meeting of NGAA, Amarillo, Texas, November 20, 1951.

MAINTENANCE And OPERATION

How To Do It—

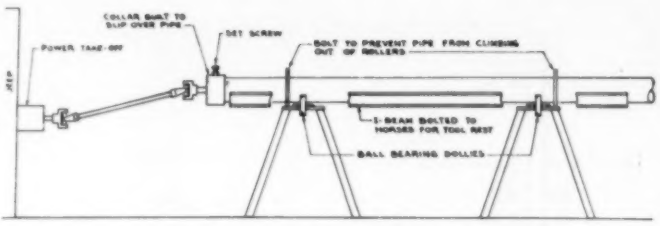


Cleaning Used Pipe

WHERE a machine is not practical or available for cleaning used pipe for painting and replacement, the hand pipe cleaner shown in the sketch will prove a useful tool for maintenance personnel. A jeep tractor or similar vehicle with a power take-off is required for the driver. The driver is attached with a universal joint to a shaft of 1-inch pipe, three feet in length. To the universal joint on this shaft is welded a swaged fitting that will just slip over the pipe to be cleaned. This collar is provided with a set screw for the purpose of clamping the pipe. The pipe is supported by two horses fashioned from 2-inch pipe and standing 24-inches high. Each horse is provided with two pipe rolling dollies. These ball bearings are welded to heavy steel plate, 3/8x18x8 inches. The two horses, placed fifteen feet apart, are tied together by welding a 3-inch I-beam on top of the dolly plates, so that the top of the beam is 2-inches from the pipe. To prevent the pipe from climbing out of the rollers, bolts are mounted on the dolly plates at the edge of the pipe.

In use, the cleaning tool is held over the I-beam in a manner similar to a wood lathe. Satisfactory cleaning may be accomplished with a variety of tools, such as files, wire brushes, chisels or cutter knives. After cleaning is accomplished, painting with a brush can be expedited by the continued rotation of the pipe. For long joints of pipe, the vehicle may be driven forward to clean the pipe in sections.

—Third Prize, Class D, W. B. Bowen, Panoma Corporation, Guymon, Okla.

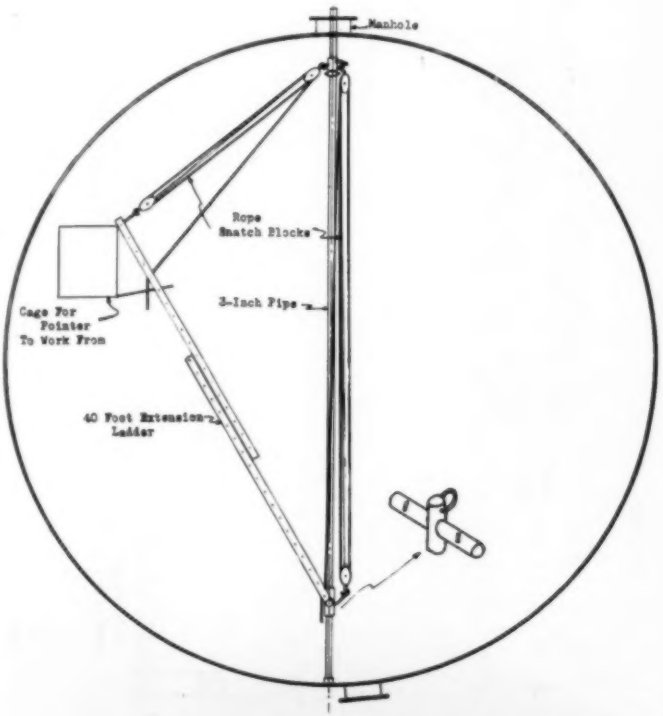

COLLAR SHAFT TO SLIP OVER PIPE
SET SCREW
POWER TAKE-OFF
BOLT TO PREVENT PIPE FROM CLIMBING OUT OF ROLLERS
I-BEAM BOLTED TO HORSES FOR TOOL REST
BALL BEARING DOLLIES

Front View (above) and Side View (right) of Pipe Cleaner.

Sandblasting and Painting Ball-Type Tanks

SAVINGS in time and labor were effected by the use of a portable scaffold for sand blasting and painting ball-type tanks. The scaffold is built on a revolving gin-pole with three adjustments for the working cage, thus allowing complete coverage of the tank. The gin-pole consists of 3-inch pipe extending through the top manhole with sleeve connections for steadiness. A sleeve is also spot welded to the bottom of the tank as a pivot for the gin-pole. This sleeve is left in the tank for future use. Two rope blocks are required for two of the adjustments for the scaffold. A cage, which is constructed of ¾-inch pipe with a wooden floor and is suspended from the end of a 40-foot ladder, constitutes the working area for the painter. The pivot base of the ladder, shown in detail in the sketch, is made of 3-inch pipe with a 4-inch sleeve, which revolves on the gin-pole. The scaffold is constructed for entrance through a 16-inch manhole.

—First Prize, Class C, by E. C. Jennings, Skelly Oil Company, Skellytown, Texas.



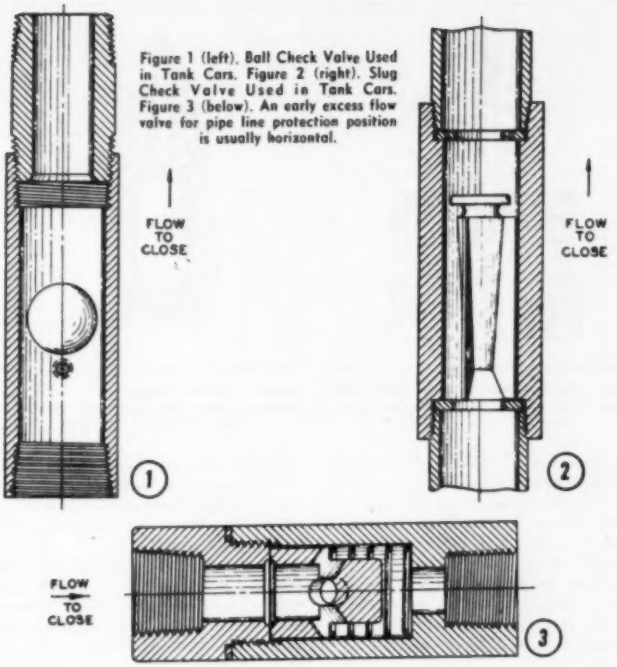


Figure 1 (left). Ball Check Valve Used in Tank Cars. Figure 2 (right). Slug Check Valve Used in Tank Cars. Figure 3 (below). An early excess flow valve for pipe line protection position is usually horizontal.

Better Excess Flow Valves For Compressed Gases

D. D. BUTTOLPH and HARRY R. ZEIGLER
Phillips Petroleum Company, Bartlesville, Okla.

HANDLING liquefied petroleum products presents special problems to processors of light hydrocarbons. The increasing demand for these products has seen a steady improvement in safety devices, such as the excess flow valve. The consequent saving in equipment damage has made the use of excess flow valves an important consideration in process design for the industry.

EXCESS flow valves promote safety in propane or butane storage and piping systems. These valves, sensitive to excessive flow, close when a hose or pipe line break vents to the atmosphere. Except for a two-way acting excess flow valve used occasionally in very long pipe lines, excess flow valves are made so they will not prevent reverse flow.

Pipe line breaks can be caused by mechanical strains due to changes in temperature or any other natural cause which directly or indirectly affect the pipes or tanks to which pipes are attached. Also some breaks have been caused by trucks or fire. There is always the possibility that tank cars or vehicles may be moved before the transfer hoses are disconnected.

Thousands of tank cars, storage tanks, tank trucks and small containers are equipped with these safety devices. A smaller number is used in pipe lines. Pipe line style excess flow valves are also used in LP-Gas truck piping, usually on the pump discharge line near where the delivery hose is attached. Greatest use is in liquid service but excess flow valves are also needed and used in vapor service. Direction of flow may be upward, downward or horizontal.

Early Excess Flow Valves

Earliest excess flow valves were installed in tank cars handling chlorine. Later on they were used in tank cars transporting liquefied petroleum gases. They were located just inside the manhole cover on liquid eduction lines which extend to the bottom of the tank and on vapor eduction lines which are above the liquid level. Excess flow valves in tank cars are of two types, ball checks and slug checks. Both depend on gravity to maintain the valve normally open until the flow reaches a certain rate. These valves have undergone very little change through the many years they have been in service. Typical valves are shown in Figure 1 and 2.

Very early liquefied petroleum gas storage tanks were installed without excess flow valves. When the desirability of such protection became apparent it was natural to try to adapt gravity type valves. To install them, tanks were emptied of liquid and vapor. Manhole covers were removed. Using a modified return bend construction, valves were installed at the bottom outlets. Working inside the tank made this installation a major revision. The reason for doing it this way was that the gravity check would only function when flow through it was upward. Once installed, the valve was inaccessible for repair or replacement except by the slow and costly process of emptying and purging the tank. Due to these nuisance considerations it was a big step forward when valves were developed which could be applied externally.

Tank car type excess flow valves

were also used in delivery truck piping. In those days of comparatively low transfer rates it was possible to use a specially designed valve, copied after the tank car slug check but much smaller and equipped with a strong compression spring to keep it open. Fortunately the pumping rate was low and the pump used could develop the discharge pressure needed to overcome the high resistance of this slug check valve.

When tank car slug check valves were being adapted to bottom outlets a new valve shown in Figure 3 was designed. This was used in vapor, air and filling lines which connected along the top of the same storage tanks. These valves had slugs of different shape, very light in weight, held open by compression springs. This design was so successful that, with some change it is a popular valve today. As will be seen in Figure 3 the fluid flow is through holes drilled in the slug.

Change in Body Style

Improvements required to make excess flow valves more useful included making them suitable for closing with any direction of flow, and a change in body style so that they could be inserted into tanks from outside. One valve, Figure 4, meeting these conditions was designed to screw into a welding flange and piping was attached to the tank by means of companion flange bolted to the welding flange. Another valve, Figure 5, screwed into a welded coupling and threads were provided at the outlet end of the valve for the attachment of the pipe. Both are held open by compression springs. Balls and slugs were replaced by stemguided discs to increase the flow area and reduce the pressure drop.

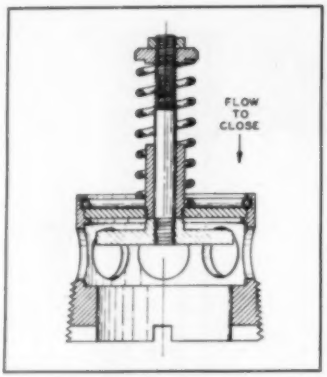


Figure 4. An Early Bottom Outlet Valve which Can Be Installed from Outside the Tank.

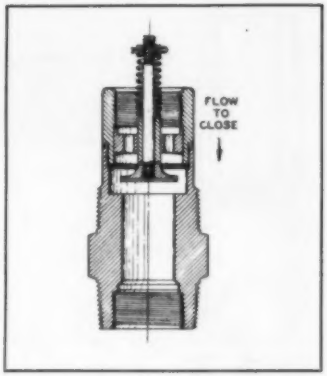


Figure 5. Another Bottom Outlet Valve which can be Installed from Outside the Tank. It can also be used in pipe lines.

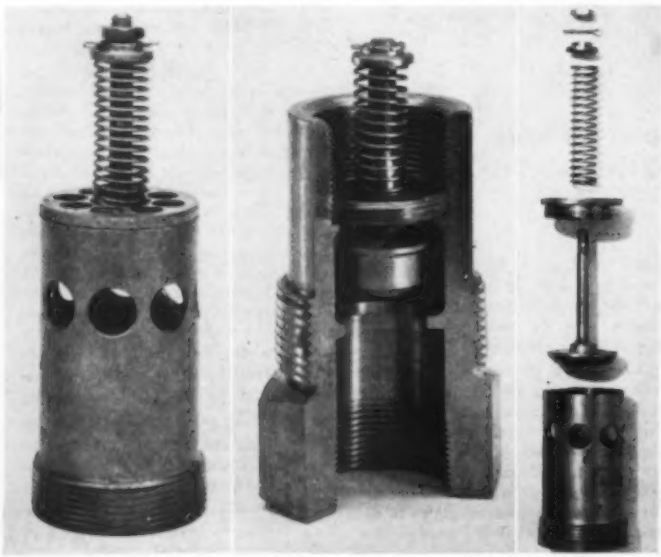
Valves inserted from the outside readily protect tanks without manholes. Therefore, this phase of excess flow valve development has resulted in a considerable advantage in cost and weight of tanks. The weight advantage amounting to several hundred pounds per tank is especially important in the case of truck tanks. Cost advantage includes reduction of material, cutting, welding and machining.

The valve shown in Figure 4 was originally made without the ring of holes through the side wall. Drilling these holes greatly increased valve capacity. Such valves must be installed to give the liquid full access around the body to take full advantage of the flow-way these holes provide. For this reason similar valves were built with much longer bodies. Diameter and location of these holes is fairly critical to obtain best results.

Ball Type the Exception

Various makes and models of excess flow valves tended to stick in the open position, one exception being the ball type valve. It can be seen in Figures 2 and 3, slug checks, and 4 and 5 stem guided valves, that there is a possibility of dirt or gummy substances interfering. Since an excess flow valve, like a fire extinguisher, should be ready to operate perfectly when needed in spite of long periods of disuse, excess flow valves should be constructed with loosely guided stems to make sure that nothing will prevent them from operating properly. The discs are self centering to compensate for the loose guides. Assembled, cutaway and exploded

Figure 6 (left). Assembled View of 2-Inch Bottom Outlet Excess Flow Valve.
Figure 7 (center). Cutaway View of 1½-Inch Excess Flow Valve for Top of Outlets of Storage Tanks. It can be used with eduction tubes for liquid withdrawal and has rated flow capacity of 3600 gallons propane per hour. Used without eduction tube for vapor withdrawal the rated capacity is 14,350 standard cubic feet propane per hour.
Figure 8 (right). Exploded View of 2-Inch Excess Flow Valve Showing body, disc and stem, guide, spring and fastenings. (These three photos, courtesy Phillips Petroleum Company).



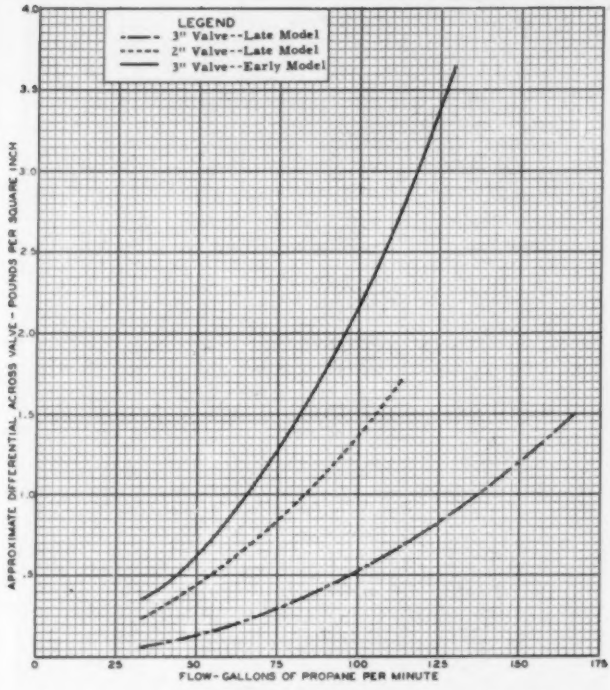


Figure 9. Pressure Drop vs. Thruput of Three Bottom Outlet Excess Flow Valves.

views of modern valves are shown in Figures 6, 7, and 8.

We have all learned, sometimes the hard way, that to transfer volatile liquids, such as propane, satisfactorily, restrictions caused by valves, fittings, pipe and so forth must be kept to a minimum. At first thought, to obtain a low pressure drop, it seems practical to use an oversize excess flow valve and reduce to the desired pipe size at the outlet end of the valve, but there are several objections to this. The larger valve would cost more for material and manufacture, reducing fittings would complicate the piping, and if installed in a tank the tank opening would be larger. A more important consideration is the attitude of the LP-Gas industry expressed in NFPA Pamphlet 58 (NBFU Pamphlet 58) paragraph B.6 (c) as follows: "The connections or line including valves, fittings, etc., being protected by an excess flow valve shall have a greater capacity than the rated flow of the excess flow valve." The industry has interpreted this to mean that the thread size of the pipe connected to the valve outlet should not be smaller than the thread size of the valve itself. As it is economically undesirable to use oversize pipe it is easy to see why excess flow valves should be constantly improved by increasing the flow capacity compared to the pressure drop.

The improvement of late model valves over early models is shown in Figure 9.

Non-Chatter Excess Flow Valve

A recent accomplishment in excess flow valve evolution is the non-chatter excess flow valve. It was found that excess flow valves in pipe lines and in eduction pipes of tanks would chatter under certain flow conditions due to liquid "hammer" effect. This chattering or hammering is undesirable and sometimes intolerable because of the noise, because of the damage often inflicted on the valve and also because of the temporary disruption of operations. Another objection to a valve which is subject to chattering is that it will often fail to stay closed in an emergency, especially at low pressure. It was necessary to carry on extensive flow tests in order to diagnose the cause of chattering and to devise a cure. As a result of much experimental work, a throttling type disk was developed which would close without chattering at unusually low upstream pressure; in most cases, the upstream or tank pressure could be as low as ten psig. The non-chatter valve is manufactured for use in tanks for the protection of top outlets and it can also be used in end outlets and bottom outlets. The same principle is used in an excess flow valve of the pipe line style (see Figure 10.)

Factors in Selection

Several considerations are necessary when selecting excess flow valves. Flow capacity of the valve must be high enough to handle desired normal quantity of fluid but it should close automatically if flow exceeds this quantity

Figure 10. Non-Chatter Pipe Line Valve.

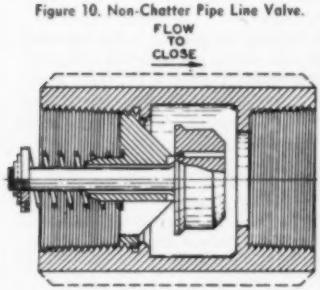
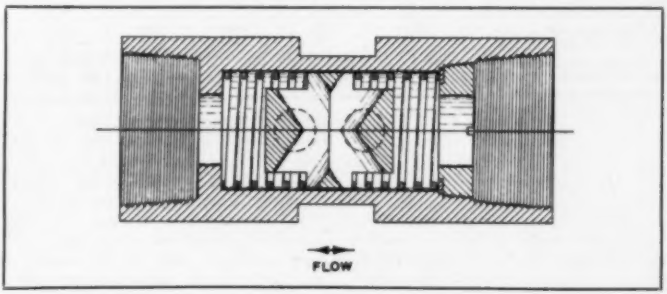


Figure 11. Double-Acting Excess Flow Valve.



materially. Usually the rating should exceed desired flow by 10 to 30 percent. Direction of flow, (whether upward, downward or horizontal) will influence capacity slightly. Vapor lines and liquid lines should be protected by these devices. Development of excess flow valves has been due to their widespread use in the LP-Gas industry but it is well to mention that they can be of great value to industries handling other combustible or lethal fluids. Since they are ordinarily rated in terms of propane flow it is necessary to convert to flow of the proposed fluid. This can be done by taking into account the respective specific gravities of propane and the fluid for which the valves are to be used.

Valve materials must be compatible with fluids passing through them. For propane and butane any of the usual metals are satisfactory and this is also true of dry chlorine. However, brass, bronze and certain stainless steels are unsuited to wet chlorine. Carbon steel is suitable for dry ammonia while several grades of stainless steel can be used for wet ammonia. These are examples at random and the valve manufacturer can determine the best metals for other services.

In the case of extensive pipe lines such as exist in large industrial, utility, or bulk storage plants, several pipe line excess flow valves may be required. It is sometimes desirable to use double acting excess flow valves (see Figure 11) in such pipe lines to prevent back flow escape of liquid due to line breakage.

Operators ask, "What protection will an excess flow valve give me?" The primary purpose is to protect against breakage of pipe lines and hose connections. It is apparent that only breakage permitting unrestricted flow, that is to say a wide separation of the broken ends, will cause the valve to close, a matter entirely out of control of the designer or user of the valve. It is also apparent that if the break is too far away from the valve the pipe line friction will retard the liquid flow below this unrestricted quantity with the result that the excess flow valve will not function as intended. Therefore the table, Figure 12, has been compiled to show the pipe line protection which can be expected when modern, excess flow valves are installed in propane tanks and pipe lines. The table is in terms of straight pipe and Figure 13 can be used to make allowance for valves and fittings in the line.

Excess flow valves should be tested annually to make sure that they will close properly. It is sometimes necessary to part the pipe line downstream from the valve being tested. If this is necessary it should be done at a spot chosen for safety reasons.

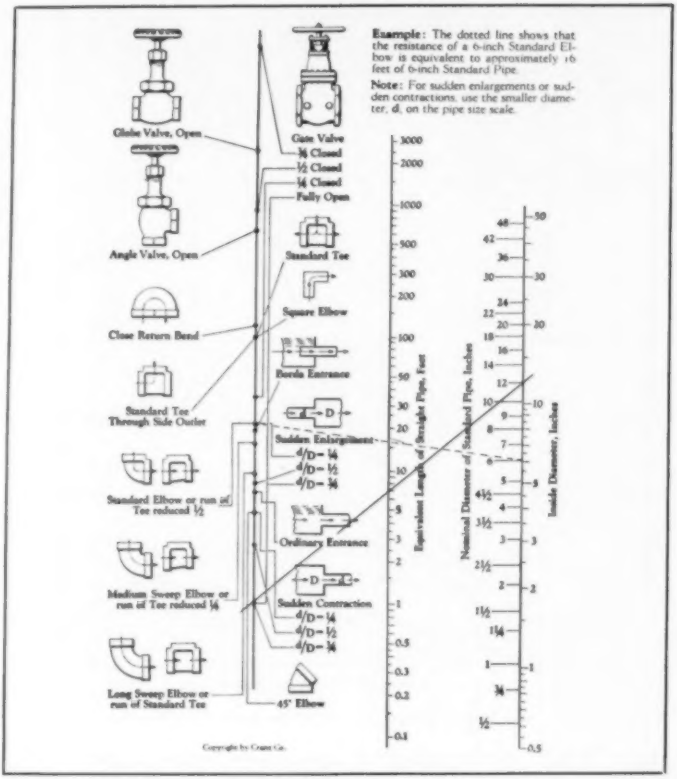

Example: The dotted line shows that the resistance of a 6-inch Standard Elbow is equivalent to approximately 16 feet of 6-inch Standard Pipe.
Note: For sudden enlargements or sudden contractions, use the smaller diameter, d, on the pipe size scale.
Globe Valve, Open
Angle Valve, Open
Close Return Bend
Standard Tee Through Side Outlet
Standard Elbow or run of Tee reduced ½
Medium Sweep Elbow or run of Tee reduced ½
Long Sweep Elbow or run of Standard Tee
Gate Valve
⅛ Closed
¼ Closed
½ Closed
¾ Closed
Fully Open
Standard Tee
Square Elbow
Borda Entrance
Sudden Enlargement
d/D = ¼
d/D = ½
d/D = ¾
Ordinary Entrance
Sudden Contraction
d/D = ¼
d/D = ½
d/D = ¾
45° Elbow
Equivalent Length of Straight Pipe, Feet
Nominal Diameter of Standard Pipe, Inches
Inside Diameter, Inches
Copyright by Crane Co.

Figure 13. Resistance of Valves and Fittings to Flow In Fluids.

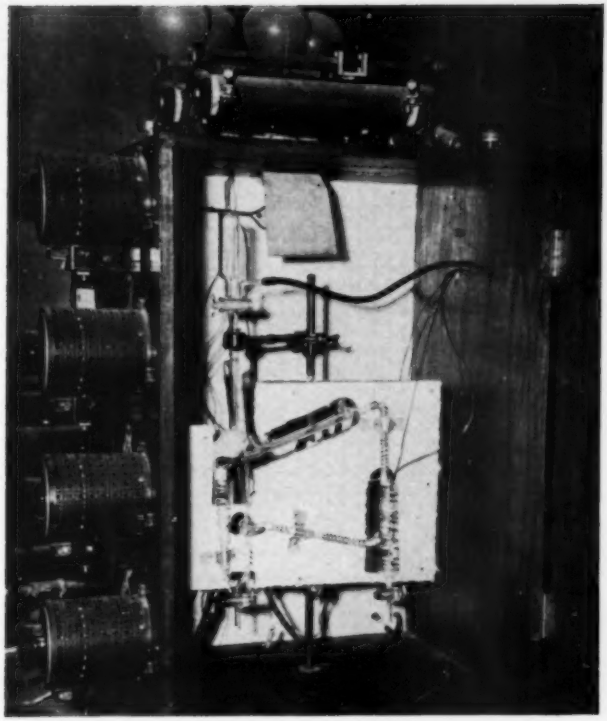
FIGURE 12

Estimated Length of Liquid Propane Pipe Line Protected by Excess Flow Valves Mounted in Horizontal Storage Tanks

(Courtesy, Phillips Petroleum Co.)

SIZE	1"		1½"		2"		2"		3"	
Closing Flow Rating (gph.)	1300		3500		6000		6800		10,000	
Closing Differential (Inches W. C.)	64		114		103		50		42	
Assumed Storage Pressure (psig.)	10	20	10	20	10	20	10	20	10	20
Straight Pipe Protected—(feet)	90	275	80	320	120	435	205	455	710	1500

* * *



Assembled View of Phase Equilibria Apparatus Showing Details of Heaters.

Equilibrium Constants of The Heavier Hydrocarbons At Subatmospheric Pressure

M. VAN WINKLE
Department of Chemical Engineering
University of Texas, Austin

NEW EXPERIMENTAL work has been done on vapor-liquid phase equilibria in systems containing dodecane, tetradecane, hexadecene, and octadecene. Experimental data on binary mixtures containing these compounds were used to develop K charts for each component covering the range 10 to 1000 mm. Hg absolute, and 100° to 700° F. Within the region of experimental data the charts in some instances show deviations up to 5 percent from the experimental values because of the characteristics of the individual mixtures.

VACUUM equilibrium vaporization constants are of particular interest to the petroleum industry because in the processing of heavy petroleum mixtures and petroleum oils by distillation methods it is necessary to resort to vacuum fractionation to make high quality products. Subatmospheric distillation is used to lower vaporization temperatures to prevent thermal decomposition of the hydrocarbon compounds at the high temperatures encountered at higher pressures. Up to the present there have been very little experimental data reported on vaporization characteristics of the heavier hydrocarbons or of petroleum mixtures under vacuum conditions. For this reason, and because of the obvious value of experimental data in this region, the author and co-workers are carrying on a research program to evaluate experimental data on heavy hydrocarbons in the vacuum region.

Some of the data resulting from this program have already been reported, and more will be published in the near future.

Equilibrium Constants

Equilibrium vaporization constants are defined as

$$K = \frac{y}{x}$$

These equilibrium constants are a function of temperature, pressure, and composition. For compounds following the ideal solution laws and ideal gas laws, equilibrium vaporization constant, K, may be expressed as the ratio of the vapor pressure of the compound at the temperature in question to the total pressure. Thus

$$K = \frac{P}{P_T}$$

where P = vapor pressure at the temperature of equilibrium and P_T represents the total pressure on the system. This relation results directly from the activity coefficient definition of

$$\gamma = \frac{yP_T}{xP}$$

where γ = the activity coefficient,
y = the mole fraction of the component in the vapor phase at equilibrium,
x = the mole fraction of the component in the liquid phase at equilibrium,
P = the vapor pressure, and
P_T = the total pressure on the system.

Thus, where ideal solution behavior is encountered, $\gamma = 1$, $K = y/x$; therefore,

$$K = \frac{P}{P_T}$$

In cases where the compounds do not behave ideally either with respect to the solution or with respect to the vapor phase, γ is not equal to 1 (or the

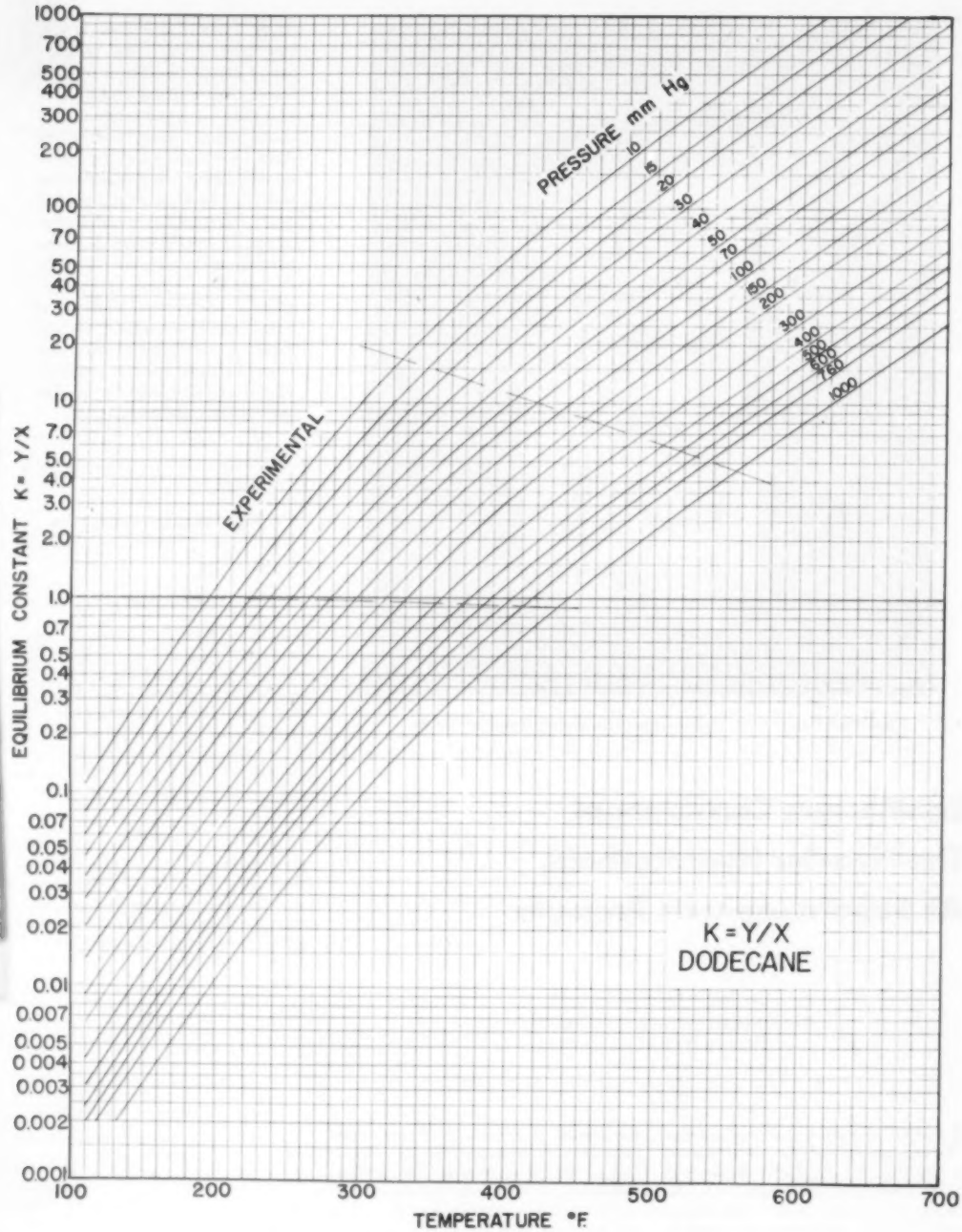


Figure 1. Vapor-Liquid Equilibrium Constant Chart for Dodecane.

activity coefficient deviates from 1). Depending upon the character of system and the type of deviation from ideality, the γ values may be greater or less than 1. Where experimental data are available to evaluate the deviation of the component from ideality or to evaluate the activity coefficient, the equilibrium vaporization constant,

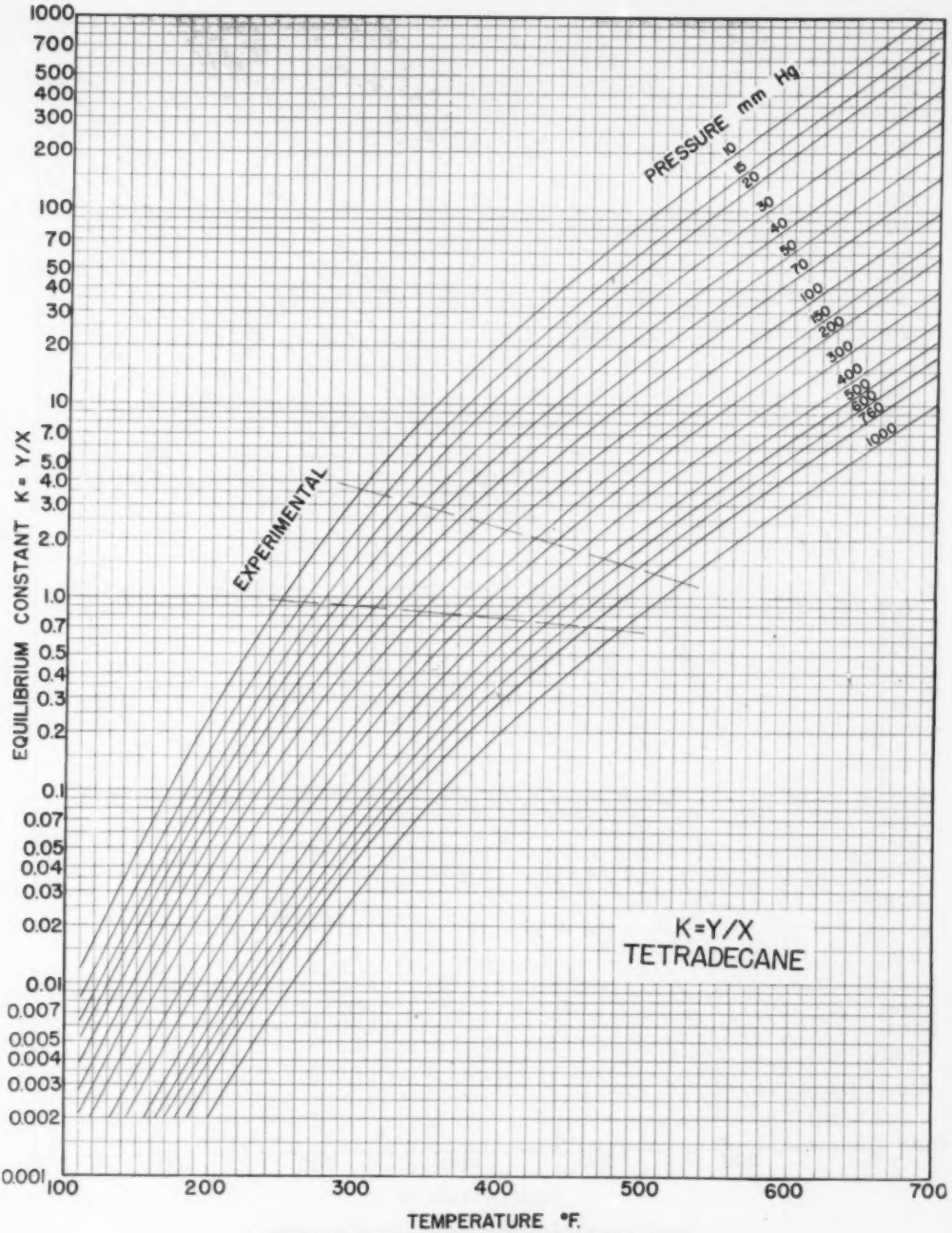


Figure 2. Vapor-Liquid Equilibrium Constant Chart for Tetradecane.

K, may be calculated as follows:

$$K = \frac{\gamma P}{P_T}$$

since

$$\gamma = \frac{K P_T}{P}$$

Deviations from ideality in the solution, or liquid, phase are a function of mixture properties including not only the effect of another component, or other components on the compound in question, but the amount, or mole fraction, of the various components present. Thus, a compound can show, and does show, a range of deviations depending upon the composition of the

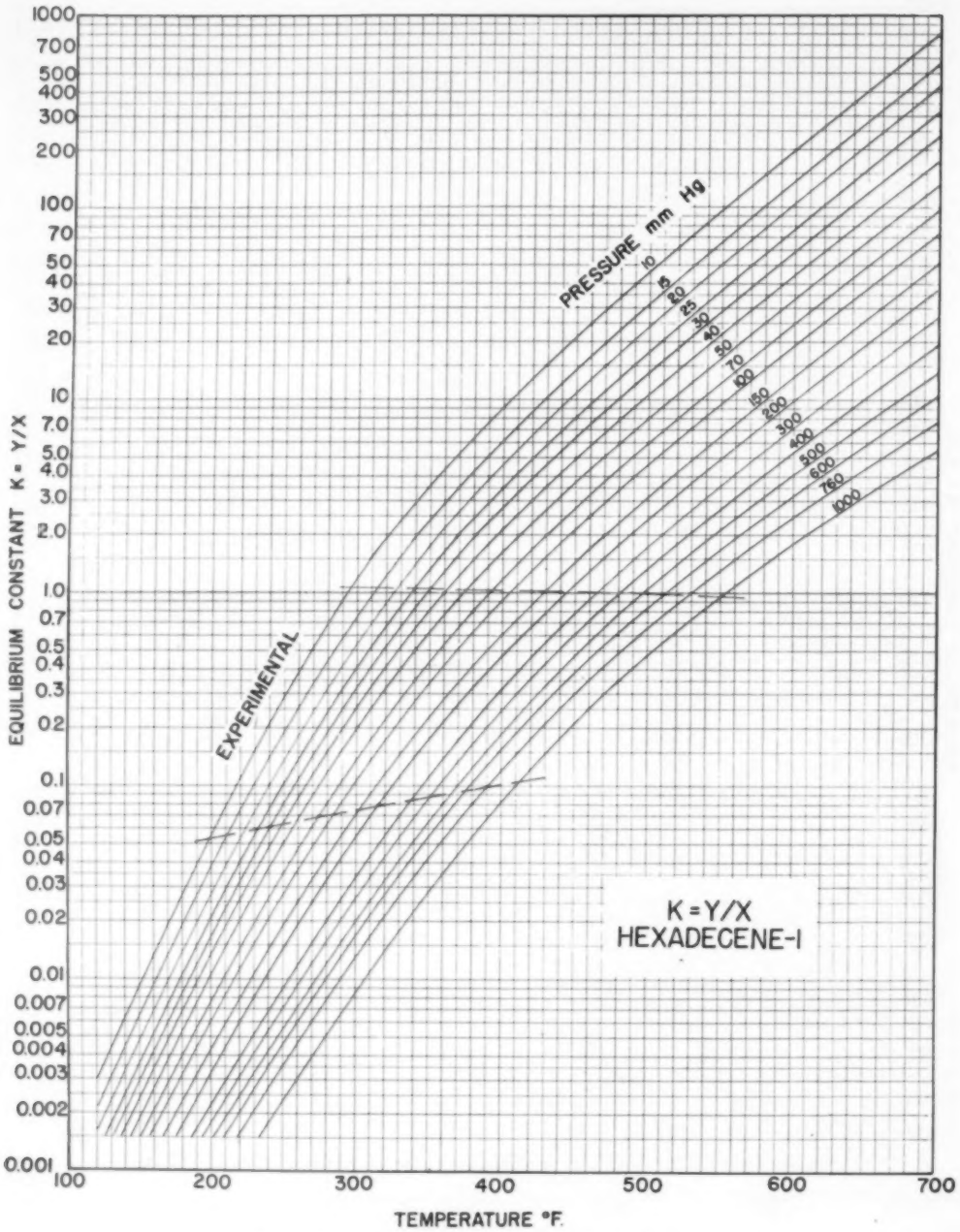


Figure 3. Vapor-Liquid Equilibrium Constant Chart for Hexadecene-1.

mixture with respect to the amount of the compound present. In addition, the deviations at constant mole fraction can vary greatly from mixture to different mixture containing the common component in question. Thus, it is evident that no one chart can represent the equilibrium vaporization constant for a compound for all mixtures and all compositions. Actually, where deviations are small; that is, the departure from ideality of the component in a range of mixtures is small, representative average K charts may be devised. It is well to remember, however,

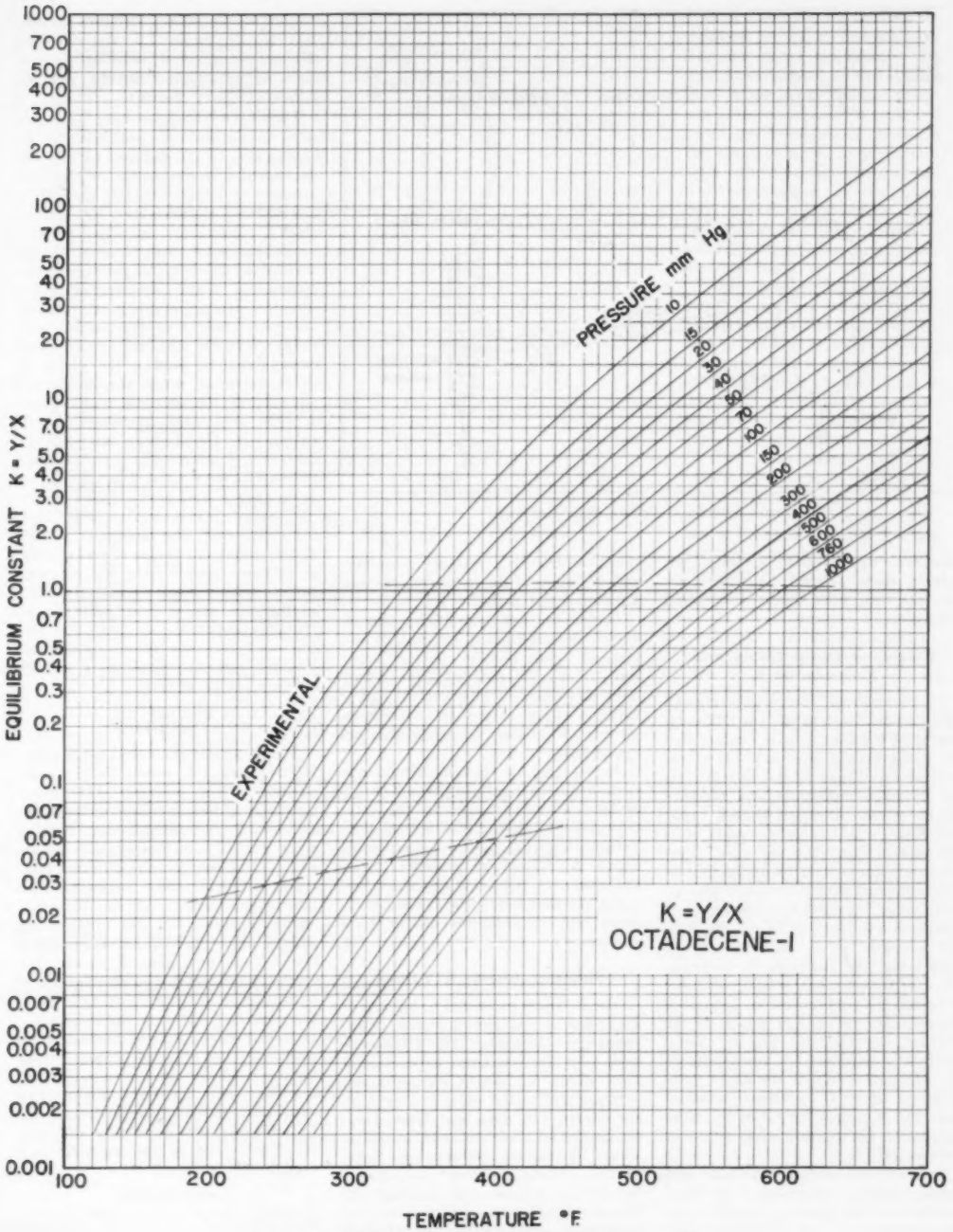
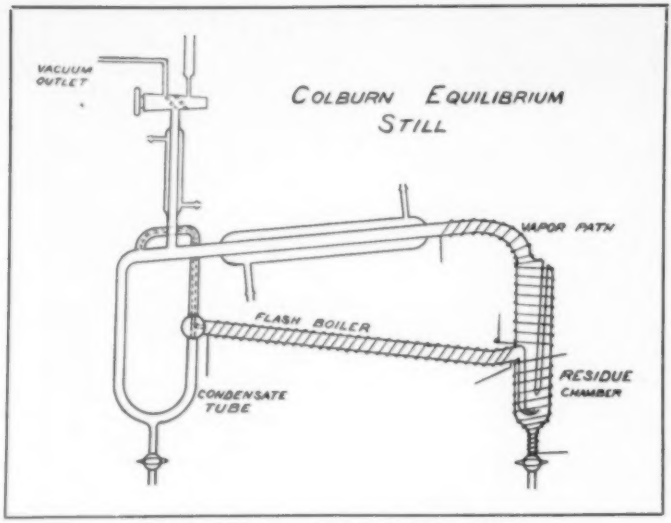


Figure 4. Vapor-Liquid Equilibrium Constant Chart for Octadecene-1.

that such charts are averages and may deviate appreciably from experimental K values derived for that compound in a given mixture at a particular composition.

Because of the nature of petroleum hydrocarbon mixtures, particularly those in the homologous paraffin series, the use of generalized K charts has been practicable. This does not result from the fact that the components behave ideally in all mixtures, but because of the fact that the deviation of the compound from ideal behavior is of such an order of magni-



Schematic Diagram of Colburn Equilibrium Still.

tude that calculations in design involving these generalized values are accurate within the limits of so-called "engineering accuracy."

Effects of Temperature and Pressure on K

In considering the vapor-liquid equilibrium constant, K, for any compound in a mixture, it is evident that the value should approach 1.0 at the critical conditions of the mixture. At the critical temperature and pressure of the mixture the two phases, vapor and liquid, do not exist—or if it is considered that they *do* exist, they have the same properties and are therefore unidentifiable as separate phases. Commonly, as pressure increases at pressures considerably below the critical pressure of a mixture the K values for the components decrease. Also, as temperature is increased, the K values for components in a mixture increase. In the critical region of the mixture wherein two phases cannot exist, it is evident that regardless of the previous trend of the K vs. temperature or K vs. pressure relationship, the K values for all of the components in the mixture must return to a value of 1.0.

Because the critical pressure and temperature is a function of the characteristics of the mixture as well as the characteristics of the individual components contained in the mixture, it is difficult to separate the effect of temperature, pressure, and mixture characteristics on the equilibrium constant. Attempts have been made[1,2,6] to correlate the so-called "convergence pressure," which is a mixture property, with K values of the hydrocarbons and associated materials.

Under vacuum conditions the K values should be less affected by deviations from ideality in the vapor state than at higher pressures. This does not imply, however, that the solution effect, or the deviation from ideality in solution, should be changed appreciably.

In the case of the paraffin hydrocarbons, the critical pressures decrease as the molecular weight of the compound increases, and the critical temperature increases. For the compounds whose K values are presented here, the range of temperatures and pressures are well below the critical pressures and temperatures of the pure compounds.

Subatmospheric K Values

The K charts presented in Figures 1, 2, 3, and 4 are for dodecane, tetradecane, hexadecene, and octadecene and were derived from experimental data within the ranges indicated and extrapolated to the ranges covered by the charts. The data were taken from the results of three different investigations: Rasmussen,[5] tetradecane—hexadecene system; Keistler,[4] dodecane—hexadecene system; and Jordan,[3] dodecane—octadecene system. These investigators obtained data at pressures of 10, 20, 50, 100, 200, 400, and 760 mm. Hg. (These data are either already published or soon will be published.) In all cases it was found by these investigators that the activity coefficients for the compounds at various concentrations in the binary mixtures do not vary greatly from 1.0. Activity coefficient-composition relations for a given compound were not the same in different binary mixtures.

The charts presented here were derived as follows. Experimental K values were calculated and plotted on the charts, with parameters of constant pressure of 10, 20, 50, 100, 200, 400, and 760 mm. Hg pressures. As a guide, ideal K values were calculated for the whole range of temperatures to be covered by the chart at pressures corresponding to the experimental pressures by using the vapor pressure of the compounds over the temperature range. Next, the temperature scale was extrapolated by plotting the log of K in experimenal range versus the reciprocal of the absolute temperature at lines of constant pressure. The K values corresponding to intermediate pressures between the experimental pressures were evaluated by plotting K versus log P and interpolating to the intermediate pressures. As a final check for consistency, the molecular weight of the compound versus K was plotted at constant temperature and constant pressure. This is not necessarily valid in this case because of the difference in type of compounds, since two are olefins and two are normal paraffins. However, in most instances a smooth curve could be drawn.

Conclusions

The K charts presented herein represent average K values for the compounds in the mixtures dodecane—octadecene, hexadecene—octadecene, and tetradecene—hexadecene. There is some variation in the actual K values of the compounds in the different mixtures, although these variations are not large. Because of the apparent small variations in this molecular weight range (170-252), it is tentatively concluded that K values for these compounds can be used for heavy hydrocarbon mixtures, bearing in mind that the K values are approximately correct and not exactly correct. It is probable that these K charts could not be used for these compounds in mixtures with very low molecular weight paraffin or olefin hydracarbons or hydrocarbons of widely different structures, such as the aromatic and naphthenic types.

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[4] Keistler, J. R., MS thesis, University of Texas (1950).
[5] Rasmussen, R. R., and Van Winkle, M., Ind. Eng. Chem., **42**, 2121 (1950).
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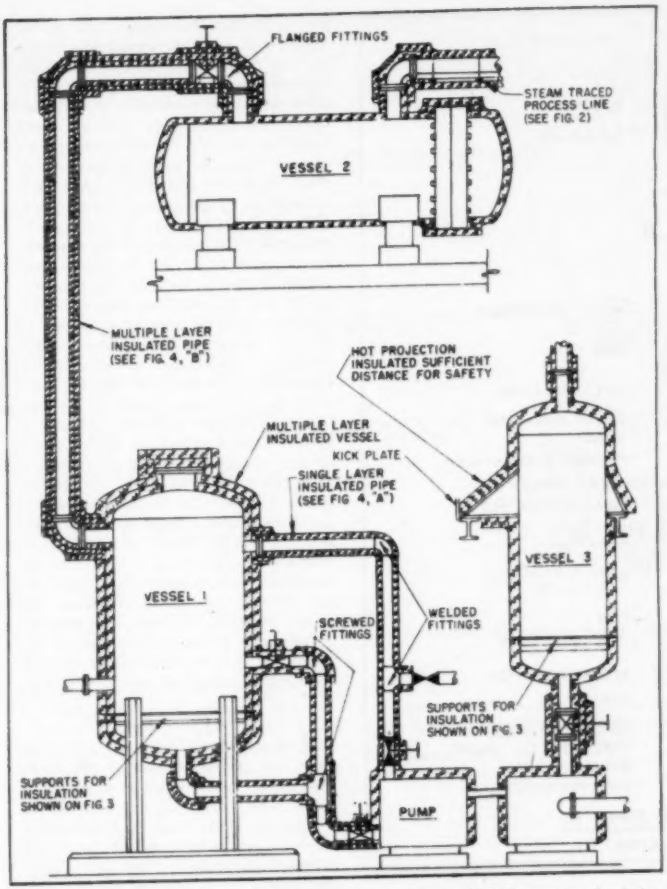
FLANGED FITTINGS
STEAM TRACED PROCESS LINE (SEE FIG. 2)
VESSEL 2
MULTIPLE LAYER INSULATED PIPE (SEE FIG. 4, "B")
HOT PROJECTION INSULATED SUFFICIENT DISTANCE FOR SAFETY
MULTIPLE LAYER INSULATED VESSEL
KICK PLATE
SINGLE LAYER INSULATED PIPE (SEE FIG 4, "A")
VESSEL 3
VESSEL 1
SCREWED FITTINGS
WELDED FITTINGS
SUPPORTS FOR INSULATION SHOWN ON FIG. 3
SUPPORTS FOR INSULATION SHOWN ON FIG. 3
PUMP

Figure 1. Schematic Details of Typical Equipment, Pump and Piping, High-Temperature Insulation.

Thermal Insulation for Industrial Requirements

Part II—Design Considerations for High Temperature Range Insulation

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THERE EXISTS no perfect insulation material that will satisfy all requirements of the design engineer; so the countless types and forms must each be evaulated in order to solve problems that arise in the processing industry. Such an evaluation should include a consideration of the thermal, physical, chemical, and moisture conditions, as well as safety, economics, availability, and time.

Part I, appearing in the January issue, presented an introduction to thermal insulation, including a discussion of insulation types, requirements, and specifications. Part II now proceeds with specific details on insulating materials for the high temperature range. Some of the application requirements of thermal insulation, their characteristics, and methods will be shown. Testing of materials and the more important functions of design also are included.

THERE are no short cuts for a properly designed insulation job. More work is ruined by the substitution of inferior specifications, improper materials and acceptance of a price by unqualified and misinformed persons than is accounted for by workmen in the field. As long as the feeling prevails that anything which can be applied to a heated surface is insulation, money will continue to be ill spent and premature failures will continue to occur.

In the insulation field we are too often misled by mistaking opinion for fact. Facts can be supplied either by suitable test, or by satisfactory field service. The first costs money to provide suitable equipment and operation, while the second may cost many times the first due to lost time and inability to correct error even when failure has been discovered. The latter course may well be charged with the use of antiquated methods so prevalent as well as the refusal to accept new or improved products. Fact by test should be a prerequisite to every large or moderate-sized installation. Since the thermal insulation or accessory manufacturer cannot afford the expense of providing all the answers it becomes obligatory on the part of the user to supply such data as is pertinent to his particular needs. Materials or methods cannot be impartially adopted with freedom from fear of the outcome unless supported by physical and thermal test data. There are no consuming companies known to the author who have adequately equipped thermal insulating testing laboratories although a few are making a determined and commendable effort in the proper direction.

Requirements of Application

Fundamentally, the main purpose of thermal insulation is to control the flow of heat. In the case of high temperature the purpose of the insulation

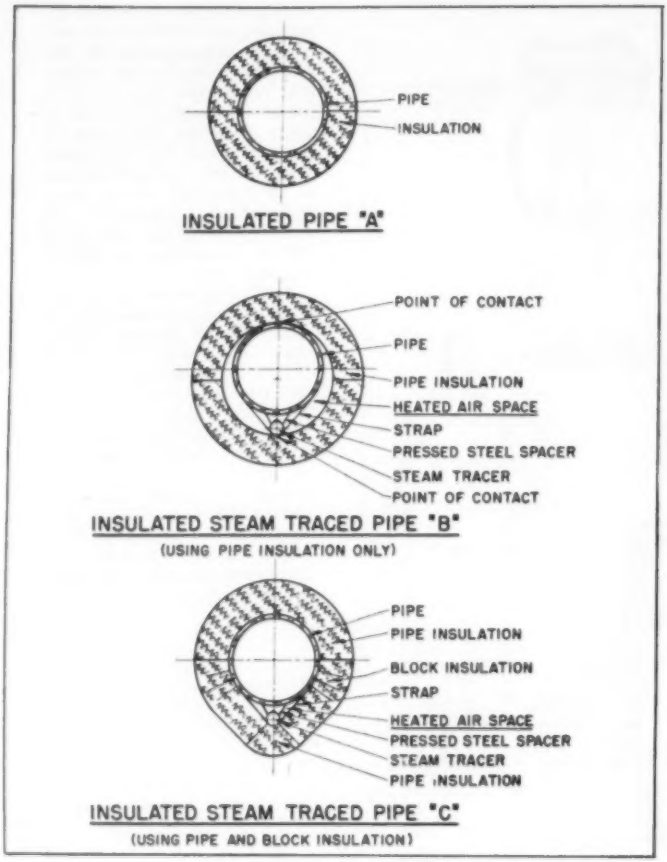


Figure 2

is to retain the heat in the equipment or piping.

The requirements of each installation must be determined in order to consider the insulating materials most adequate for the job. These application requirements might well be broken down into four parts: 1) thermal, 2) physical, 3) chemical, and 4) electrical.

These parts are not of the same relative importance; therefore it is important, after the requirements are determined, that their relative values also be determined insofar as possible.

There may be a maximum rate of heat loss indicated in the design of the vessel; if so, this maximum rate is the first thermal requirement to be considered. On the other hand, certain processes may require that a certain amount of heat be lost, but not to exceed a given figure, in which case the design may be restricted to very narrow limits. In some cases, such as steam traced lines, two thermal conditions may have to be considered—the proper insulation for the operation of the process line and the proper insulation to prevent the freezing of the process line when it is not in use. In addition, it may be necessary to restrict the amount of heat loss to the surrounding area either because of process safety or personnel safety. This, of course, must be calculated from the allowable heat loss per square foot of exposed surface through the insulation. The operating temperature is always a factor for consideration, since a material must be able to withstand the maximum operating temperature to which it is subjected.

The physical properties of a material should satisfy the requirements of the application. Some high temperature applications are designed with jackets packed with insulating material. In other applications the insulation must support itself and the outer finish. In some instances the insulation is so located that it is subject to mechanical abuse, such as being walked upon, or supporting heavy leaning objects and in this case high compressive strength is desirable. Other applications require that the insulation bridge a gap, such as where installed over ribs or stiffeners, or over steam tracing. In applications such as these, high flexural and high tensile strength is of paramount importance.

In some cases it may be necessary to strengthen the insulation by supporting it with expanded or solid sheet metal, hardware cloth or other means. There are applications where the insulation material may be subjected to serious vibration or sudden shock. Problems of erection are also to be considered. The material selected must have the properties suited to the particular problem involved. Since expansion and contraction of the vessel or pipe must be properly provided for if serious consequences are to be avoided, provision must be made to build expansion joints in the insulation. A single layer of very rigid insulation applied on a vessel at atmospheric temperature (see Figure 4) can develop serious cracks when the vessel expands at high temperature, particularly if much shrinkage of the insulation occurs. Multiple layer will reduce this hazard at least 50 percent.

Moisture a Factor

Moisture in the form of vapor or water must always be considered. Some insulations resist the action of water better than others. If, for example, a number of lines are to be installed out of doors and time is a factor, a water resistant material should have preference should it become necessary to install the insulation in damp weather. If an insulation on elevated temperature becomes wet during application it is frequently necessary to wait until the line or vessel goes into operation in order for the heat to dry the insulation before the weather-proofing can be applied. This can be serious since there is never sufficient heat to expel all the moisture from the outer surface and it at once becomes a hazard for the weatherproofing material. Another moisture problem arises in the case of insulation being installed on lines or vessels which may be without heat for considerable periods of time. A highly absorptive insulation will collect moisture which may cause damage to the vessel or pipe through corrosion.

In some instances appearance may be a deciding factor. Some insulations, due to their nature, cannot be fabricated to a smooth even surface and exact dimensions, although other properties may be outstanding.

The chemical properties of thermal

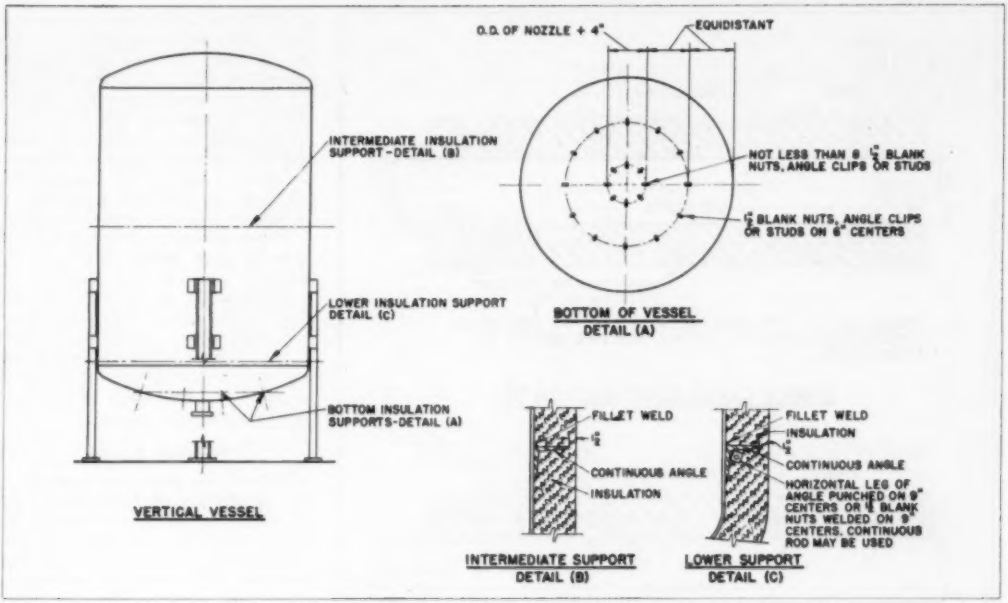


Figure 3. Insulation Supports for Vertical Vessel

insulation materials are too little known but should be explored because reaction through contact with certain chemicals may be the cause of fires whose origin is unsuspected.

Electrical properties at high temperatures are generally not too important because the moisture is usually driven outward so that galvanic action does not occur. However, in special cases piping or equipment is electrically heated and in such applications the electrical insulation properties are as important as the thermal insulating properties.

Characteristics of Insulation And Accessories

The thermal insulation chosen for any particular job of insulating should be the one which most nearly fulfills the requirements of the application.

The characteristics of the materials are in some cases difficult to determine. No manufacturer of thermal insulation materials has complete information regarding all of the characteristics of his materials. In some instances the consumer must run tests to determine values in question. In other instances when no values can be obtained, since tests are not satisfactory or not developed, the engineer must use his own judgment based on past experience to evaluate the properties in question.

Properties to be used to check against the requirements of the application to determine those desired of the thermal insulation are as follow:

Dimensional Properties
- A) Shape and sizes
  - 1) Straightness
  - 2) Smoothness
- B) Shrinkage (excessively large voids)
- C) Coverage
- D) Density

Thermal Properties
- A) Conductivity
  - 1) Effect of temperature
  - 2) Effect of moisture
  - 3) Effect of joints
  - 4) Effect of tie wires, etc.
- B) Specific Heat
  - 1) Effect of temperature
  - 2) Effect of moisture
- C) Thermal Diffusivity
- D) Thermal Emissivity
- E) Thermal Absorptivity
- F) Temperature Range—Max. and Min.
- G) Expansion and Contraction
- H) Resistance to Flame

Physical Properties
- A) Compression Strength
- B) Compressibility of Blanket or Fill Materials
- C) Tensile Strength
- D) Flexural Strength
- E) Impact Strength
- F) Compression—Shear Strength
- G) Hardness—Surface
- H) Abrasion Resistance
- I) Indentation Strength
- J) Tearing Strength of Blanket and Sheets
- K) Loss of Strength due to fatigue
- L) Folding Endurance of Sheets and Films
- M) Resistance to thermal shock
- N) Temperature Effect on Strength

Moisture Properties
- A) Water Migration
- B) Vapor Migration
- C) Vapor Migration through Joints, Cracks, Tape, etc.
- D) Effect of Temperature, Humidity and Air Motion on B & C
- E) Relation of Thickness Resistance to Vapor Migration
- F) Relation of Vapor Barriers to Thermal Insulation in their ability to be used together

Chemical Properties
- A) Chemical Analysis
- B) Corrosive Properties—Alkalinity, pH
- C) Corrosive Properties in combination with other materials
  - 1) With Moisture present
  - 2) With Process Chemicals present
- D) Smoke Point—Alone or with chemicals present
- E) Flash Point—Alone or with chemicals present
- F) Auto—Ignition Point—Alone or with chemicals present

Electrical Properties
- A) Resistance to Electrical Flow, Dry, Wet
- B) Galvanic Action

Workability Properties
- A) Cutting Characteristics of Solids
- B) Fitting Characteristics of Solids
- C) Forming Characteristics of Solids
- D) Adhesive Characteristics of Cements and Mastics
- E) Pouring Characteristics of Cements and Mastics
- F) Troweling Characteristics of Cements and Mastics
- G) Brushing Characteristics of Mastics
- H) Handleability of Material
- I) Personnel Reaction—Effect on skin
- J) Toxic Hazard of Application (Solvents in mastic, etc.)

Protection of Insulation

The selection of the accessories is as

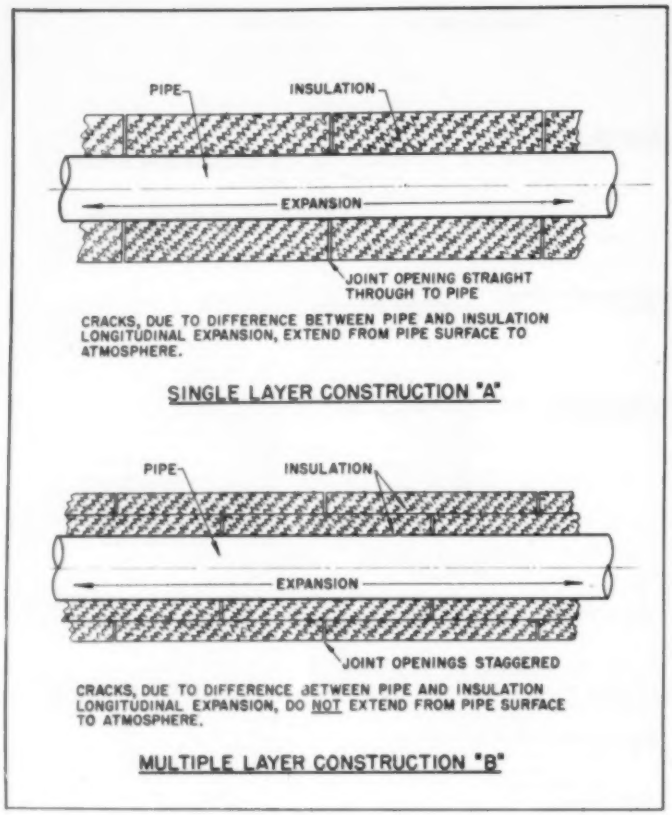

PIPE
INSULATION
EXPANSION
JOINT OPENING STRAIGHT THROUGH TO PIPE
CRACKS, DUE TO DIFFERENCE BETWEEN PIPE AND INSULATION LONGITUDINAL EXPANSION, EXTEND FROM PIPE SURFACE TO ATMOSPHERE.
SINGLE LAYER CONSTRUCTION "A"
PIPE
INSULATION
EXPANSION
JOINT OPENINGS STAGGERED
CRACKS, DUE TO DIFFERENCE BETWEEN PIPE AND INSULATION LONGITUDINAL EXPANSION, DO NOT EXTEND FROM PIPE SURFACE TO ATMOSPHERE.
MULTIPLE LAYER CONSTRUCTION "B"

Figure 4

important as the selection of the insulation itself.

The securement of the thermal insulation to the pipe or equipment is the first accessory problem to be solved. The insulation may be secured by the use of adhesives, clips, wire, strap or any other type of fastening. The fastening must be sufficient to support the insulation without causing too much heat transfer and with consideration given to expansion or contraction. Ties which may rust or corrode causing them to break should not be used, as a complete breakdown of the insulation will result. Wire netting used over block insulation must be given the same consideration.

The protection cover of insulation in most instances serves more than one purpose. Where used indoors the jacket strengthens the surface and provides a surface suitable for painting. Outdoors a jacket must provide a surface strengthening, a watershed and surface suitable for painting. The jacket must provide other protection where it is required. Locations subject to mechanical abuse must be protected by the use of a sheet metal jacket or similar protection. In other cases the jacket must provide protection from possible spillage of process fluids which may damage the insulation. Special consideration must be given in places where steam traps blow or drip on the insulation.

Tests of Insulations

As previously mentioned many of the properties of insulation which should be known are not available. This condition makes it imperative that the customer run special tests to determine properties as well as test for ordinary quality control. Many test methods have been published by the American Society for Testing Materials, Bureau of Standards of U. S. Department of Commerce, U. S. Navy and other organizations specifically interested in thermal insulating materials.

Design

The choice of insulation and the thermal calculations must go hand in hand. The material must be chosen for its thermal, physical and chemical properties. However, if the conductivity of the material is such that the desired resistance to heat flow cannot be obtained with a reasonable thickness of insulation it may be necessary to choose a material of less desirable physical or chemical properties to obtain the required thermal resistance.

When definitely determined which material most nearly fulfills all the thermal, physical and chemical requirements, the next problem becomes that of application. Reference insulation applications are shown in Figure 1 as a typical equipment, pump and piping layout, insulated for high temperature, and both single and multiple layer insulation is shown.

Multiple Layers?

One of the first considerations of the application of high temperature insulation is whether or not multiple layer application is advisable. Generally speaking, wherever 3-inch thick or more of insulation is justified the temperature is sufficiently high to warrant the use of multiple layer insulation to offset the effects of vessel or pipe expansion which cause cracks to open in the insulation. It should be noted that single layer construction ("A" Figure 4), pipe insulation is subject to cracks at the ends of each section due to the expansion of the pipe. These cracks may extend from the atmosphere to the pipe itself, and such cracks can cause excessive heat loss. In addition to the excessive heat loss these cracks may damage the canvas or weatherproofing due to the excessive temperatures at these points. Most of these difficulties can be eliminated by the use of multiple layer insulation installed with the horizontal and circumferential joints staggered, as shown in "B" Figure 4.

Steam traced lines present problems in many ways—first, as shown on Figure 2 "B" when insulation of both lines is done with a single section of larger pipe insulation. This installation requires the insulation to be of high tensile and flexural strength as it is only supported at the top and bottom. The use of single section installation does extend the heated air space up around both sides of the process line, allowing a more uniform heating. Of course, in some instances it may be desirable that the heated air space be kept to a minimum. This can be done by the installation method shown on Figure 2, "C". The expense of this latter method of installation will be greater as it requires the use of two different sections of insulation fitted with block between.

The minimum temperature required to prevent the freezing or solidification of the liquids in the process line determines both the required thermal resistance of the insulation and the required temperature of the heating line. Insulation of a specified resistance must occasionally be applied to divorce the lines in these services. Not all heated process lines are steam traced. It may in some instance, for process lines containing low boiling liquids, require that the heating line be lower than 212° F. In these cases controlled temperature hot water is frequently used as the heating medium. The insulation of steam traced lines is often designed to fulfill two different functions. One of these is the function of insulating the process line for the temperatures of the process lines in operation and the other is the insulating of the line to prevent freezing of the materials in the line when it is not in operation. It might be well to point out that if the temperature of the material in the process line is to be kept constant then the heat from the tracer must balance the heat loss from the insulation.

Problem of Securement

Although the insulation problem of pipe and equipment is similar, the problem of securement of the insulation to the equipment may be more difficult. For example, a proper method of supporting insulation to the vessel body and bottom head of Vessel 1 shown on Figure 1 is shown in detail in Figure 3. The insulation is held to the vessel body (on this or any other round equipment) by banding to the surface with strap. A support around the bottom of such equipment should be provided to prevent the insulation from slipping. If the vessel is over 12 to 15 feet high, additional supports every 12 or 15 feet should be provided to prevent excessive compression of the lower insulation material.

Bottom head insulation fastenings are also shown on Figure 3. Any type of fastening which is firm and strong is acceptable as long as its centers are sufficiently close together for lacing or banding the insulation securely to the underside of the head. Special care should be taken that the welding of supports, to vessels of clad materials or to vessels of thin materials, shall not cause burning through or excessive pickup of undesirable elements. Insulation may be secured to the underside and sides of flat equipment and supported in the same manner as shown for the bottom head. In this case the blank nuts, or other approved securement, should be on 12-inch staggered centers on the underside and on 18-inch staggered centers on the sides.

The strap or wire used to band or lace the insulation to the supports should be resistant to corrosion from fumes, chemicals, or moisture which may be present.

Insulation of the pump shown on Figure 1 must be a study unto inself depending on its shape and the particular conditions involved. Many pumps have irregular shapes and points which cannot be covered with insulation so that each must be insulated as an individual case and no general recommendations can be made.

Not shown on the schematic drawing, but a common problem, is the insulation of pipe expansion joints. A method of installation, which has proved satisfactory is shown on Figure 5. It should be noted that the mineral wool cement at each end should be installed so it remains soft and pliable to permit movement without cracking.

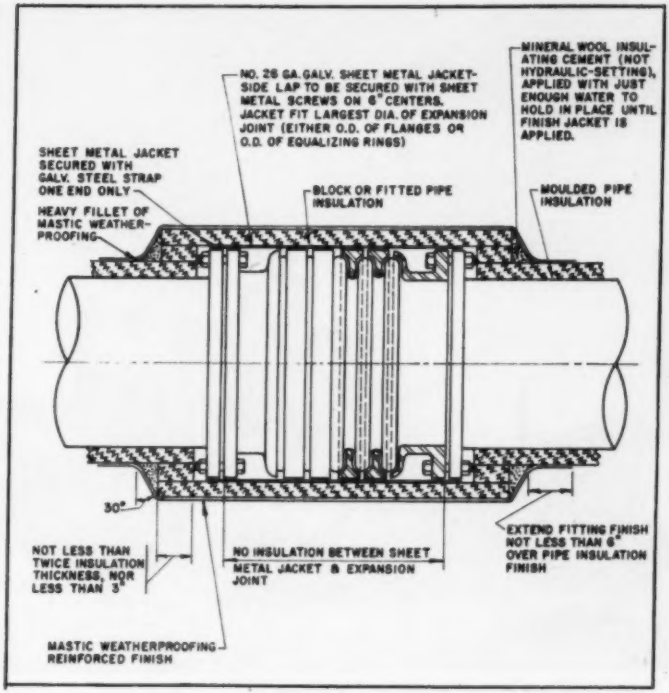

NO. 26 GA. GALV. SHEET METAL JACKET-SIDE LAP TO BE SECURED WITH SHEET METAL SCREWS ON 6" CENTERS. JACKET FIT LARGEST DIA. OF EXPANSION JOINT (EITHER O.D. OF FLANGES OR O.D. OF EQUALIZING RINGS)
MINERAL WOOL INSULATING CEMENT (NOT HYDRAULIC-SETTING), APPLIED WITH JUST ENOUGH WATER TO HOLD IN PLACE UNTIL FINISH JACKET IS APPLIED.
SHEET METAL JACKET SECURED WITH GALV. STEEL STRAP ONE END ONLY
BLOCK OR FITTED PIPE INSULATION
MOULDED PIPE INSULATION
HEAVY FILLET OF MASTIC WEATHERPROOFING
30°
EXTEND FITTING FINISH NOT LESS THAN 6" OVER PIPE INSULATION FINISH
NOT LESS THAN TWICE INSULATION THICKNESS, NOR LESS THAN 3"
NO INSULATION BETWEEN SHEET METAL JACKET & EXPANSION JOINT
MASTIC WEATHERPROOFING REINFORCED FINISH

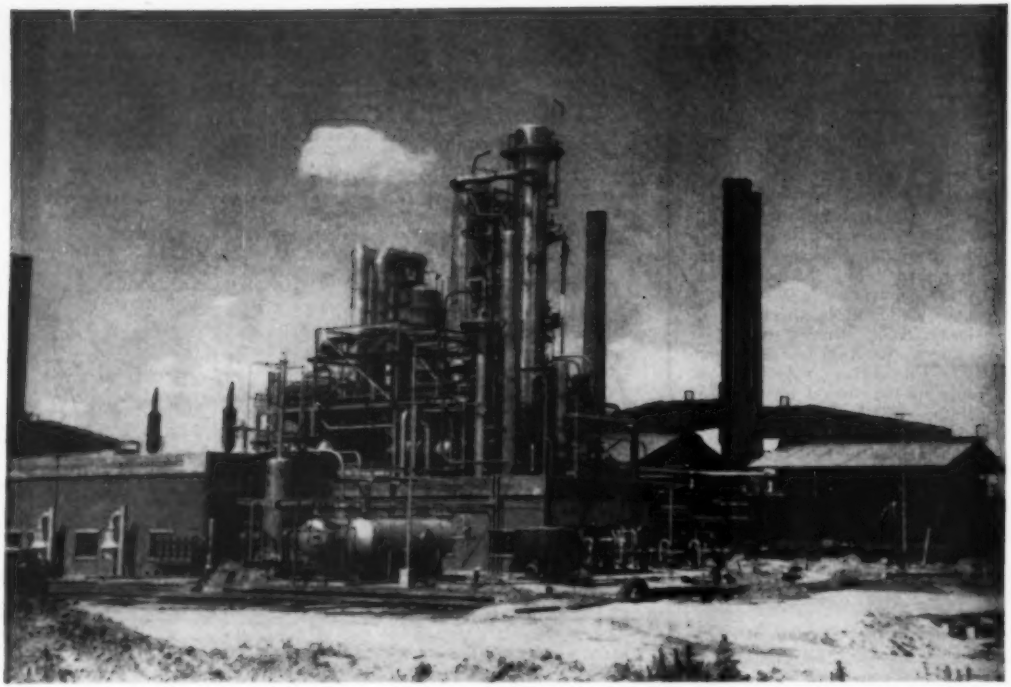
Figure 5. Application of Insulation to Hot Service Expansion Joints

Outdoors, or wherever it is necessary to waterproof the insulation, care must always be taken to be sure the insulation or insulating cement is reasonably dry before the waterproofing is applied and sealed. If moisture is sealed in the insulation, when the temperature is raised in the equipment or piping, it is likely to cause enough vapor pressure under the weatherproofing to cause blistering. Special care must be taken to cut back any weatherproofing or flammable material from any hot projections to avoid the possibility of scorching, or other damage.

The succeeding part will be devoted to points to include in a specification for hot insulation, its application, inspection and maintenance.

End of Part II. Part III will appear in an early issue.

* * *



General View of Viscosity Breaking Unit of the SIPB at Antwerp, Belgium. Refinery is expected to have its formal opening in the spring.

Antwerp Refinery Built Through Cooperation of All Levels

WHEN the first major Belgian refinery started operations last November with a capacity of 29,000 barrels daily, it went on stream with a cargo of Middle East crude which had been delivered in Antwerp early that month by the tanker "British Patience."

Owned jointly by the British Anglo-Iranian Oil Company and the Belgian group Petrofina, the refinery comprises a crude distillation unit, visbreaker and thermal cracking unit, reformer, redistillation unit, cracked P.D. acid treating plant, kerosine acid batch washer and copper chloride treaters. It produces both premium and regular grade motor gasoline, kerosine, gas oil and a variety of fuel oils. Eighty percent of the finished products will be carried by barge over the Benelux area canal network, the remaining by rail tank car and trucking.

The power plant consists of two 4250-kw turbogenerators and four 75,000 pounds per hour, 600-psi boilers. Cooling water for the refinery is pumped from the new petroleum dock and discharged, after passing through the processing units, via a safety holding basin to the river.

The genesis of the refinery dates back to 1947 when AIOC. Commercial relations with the Belgian Petrofina group had already been established by AIOC and it became obvious that the combined outlets in the Benelux countries, part of Switzerland, and the Rhineland would economically justify the erection of a large joint refinery.

In addition, the Belgian government, anxious to see a modern refinery constructed in that country, promised the project full support. The two parent groups formed a joint operating company, the Societe Industrielle Belge des Petroles, in 1948 and selected a 375-acre site about five miles below Antwerp. The Antwerp municipal authorities agreed to build a deepwater petroleum dock alongside the refinery site.

Contracts for the process units and associated off-site facilities were placed with an American firm, and British firms erected a complete power and steam generating plant. Because the polder subsoil contained an upper strata of approximately 15 feet of highly compressible peat, pre-reinforced concrete piles driven into good bearing sand 50 feet below the surface were adopted to hold the process plants and other concentrated loads. The storage tanks are standing firm on peaty soil.

Currency exchanges in Belgium made it possible to exercise considerable degree of choice in the source of supply as between Belgium, Britain and the United States, although an essential feature of the procurement policy was to obtain the maximum amount of material from Belgium.

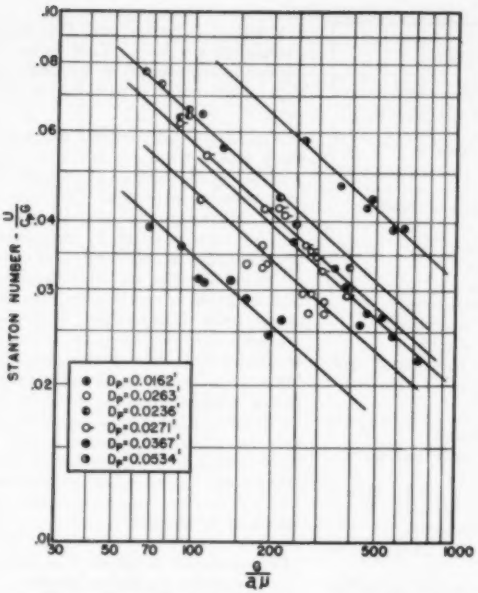


Figure 1. Heat Transfer in the 2-Inch Chamber While Cooling the Gas.

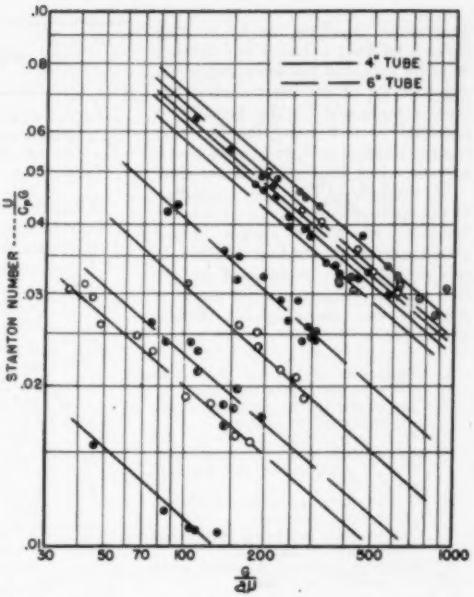


Figure 2. Heat Transfer in the 4-Inch and 6-Inch Chambers While Cooling the Gas.

Heat Transfer and Pressure Drop In Fixed Beds of Spherical And Cylindrical Solids

Part II. Heat Transfer and Temperature Gradients

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THE VARIABLES involved in any packed bed transfer have been developed in previous works but in some cases the data are conflicting and in other only a small range of particle or chamber sizes have been investigated. The work reported here was undertaken to extend and clarify the existing knowledge of fixed beds of packed solids.

Part I, appearing in Petroleum Refiner, December, 1951, treated pressure drop and packed bed characteristics. Part II, concluding the series, now presents new results on the heat transfer characteristics of several fixed packed beds. Data have been obtained to facilitate engineering calculations and to develop a better understanding of the fundamentals involved. Packings with widely different physical and thermal properties have been studied in several vertical cylinders in order to make the correlations as general as possible. A non-reacting system has also been used to keep the heat transfer independent of any reaction. The equations proposed are thus quite general when the flow is turbulent.

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THE heat transfer characteristics of several fixed packed beds have been determined as a part of an overall investigation of such systems. Data have been obtained to facilitate engineering calculations and to develop a better understanding of the fundamentals involved. Packings with widely different physical and thermal properties have been studied in several vertical cylinders in order to make the correlations as general as possible. A non-reacting system has also been used to keep the heat transfer independent of any reaction. The equations proposed are thus quite general when the flow is turbulent.

Theory of Heat Transfer in Packed Beds

The analysis of the heat transfer processes in packed beds has followed somewhat the same pattern as the study of pressure drops. In early investigations the mechanisms were not fully understood and it is quite understandable that many simplifying assumptions were made which later proved to be faulty. Fortunately, however, the basic premises of heat transfer were developed quite early and served as a springboard for packed bed applications.

As the technology has developed the line of attack has been by means of

dimensional analysis, or by writing differential heat balances and solving them by accepted mathematical methods. The use of the latter method has been complicated by the number of potential variables and the fact that certain assumptions are always necessary to arrive at a workable solution.

Mechanisms of Transfer. Regardless of the approach used it must relate the variables which are present in the actual mechanisms of heat transfer. In this regard it may be assumed that the flow of heat within a mass of granular material may occur by six distinct processes:

1) Conduction within the solid and from one particle to the other.
2) Conduction in the fluid by virtue of a temperature gradient.
3) Heat interchange between the phases which is the result of a temperature gradient between the fluid and solid.
4) Flow of fluid across an established temperature gradient.
5) Flow of solid across an established temperature gradient.
6) Radiation between the solid particles across the voids.

These six cover all of the possibilities regardless of the system.

The conduction effects occur:

1) In the fluid.
2) Within the particle.
3) Between the particles.

For the first two cases the thermal conductivities are usually low, while in the third only point contact, or a reasonable facsimile, is ever attained and the area through which heat might flow is quite small. The radiation effects quite obviously depend on the temperature gradient, the particle size and the emissivity, but in the average case the net effect is small. In fact, radiation and conduction are most conveniently combined into one term which is usually known as the effective conductivity.

Convection, on the other hand, accounts for the major share of the heat flow, particularly in the turbulent region. As the fluid passes through the bed, violent eddy currents are set up which give forced convection of large magnitude. In addition, artificially high velocities are induced as the fluid is forced through the voids, which reduces the film thickness and increases the coefficient. The primary means of transverse flow then can be traceable to two mechanisms.

First, even though the main gas flow is axial, there is some degree of cross flow between the main channels, the degree of this flow depending primarily on the shape and the size of the packing. Secondly, the fluid picks up heat on the hot side of the channel and by means of conduction and convection transfers it to the colder side. This heat is then transferred through the particle and the relatively stagnant fluid to the next channel, which would only be one particle diameter away in a uniformly packed bed. This latter mechanism has been found to be of negligible importance in the study of high conductivity particles in this work.

NOTATION

A_p = effective area of a particle.
a = effective area of heat transfer per unit volume.
C_p = specific heat @ constant pressure.
D_p = equivalent particle diameter.
D_t = tube diameter.
E = eddy diffusivity.
f_1 = fraction voids.
G = mass velocity (lb. per hr. per sq. ft. cross-section).
g = acceleration of gravity.
G' = rate of flow of solids.
h = heat transfer (film) coefficient.
J_0 = Bessel function of zero order and first kind.
J_1 = Bessel function of first order and first kind.
J_h = dimensional heat transfer coefficient.
K = over-all fluid — solid effective thermal conductivity.
k = thermal conductivity.
k_g = thermal conductivity of the fluid.
k_p^o = thermal conductivity of packed bed with stagnant fluid.
k_p = effective thermal conductivity of packed bed with flowing fluid.
k_s = thermal conductivity of the particles.
k_v = effective thermal conductivity of the packing in a vacuum.
L = depth of packing.
L = linear measure.
m = correction factor for the conductivity and shape of particles.
P = pressure.
r = radial distance from center line.
R = radius of chamber.
R_c = arbitrary constants, a function of (aD_t).
R_h = arbitrary constants, a function of (aD_t).
R = arbitrary constants, a function of (aD_t).
t = temperature at any point in the bed.
t = entrance temperature of gas.
t_h = temperature adjacent to the wall.
t_{out} = entrance temperature.
t_{ex} = exit temperature.
V = velocity.
v = kinematic viscosity.
α = thermal diffusivity $= \dfrac{k}{C_p\rho}$
$\beta = \dfrac{K}{C_pGR^2}$
ρ = density.
Θ = temperature (difference).
μ = dynamic viscosity.

Methods of Correlation. As previously stated, there are two basic approaches to the solution of packed bed heat transfer problems. The one is based on dimensional analysis which can be very effective in describing processes such as this in terms of overall variables. The use of differential heat balances is much more effective in the sense of describing what goes on, but in the past has given no more accurate results since certain simplifying assumptions were necessary to obtain a readily workable solution. In most cases the differential equation can only be solved by expansion into a series, which with the number of variables present gives a long expression. For clarity the two approaches are discussed separately.

Dimensional Analysis for Heat Transfer in Packed Beds

An equation may be developed for the conservation of heat. From this equation three dimensionless numbers may be obtained, the Peclet, The Nusselt and the Stanton. Since flow characteristics and fluid properties are also potential variables, other such dimensionless groups must be considered. The more important are as follows:

$$\text{Euler (Eu)} = \frac{P}{\rho V^2}$$

$$\text{Grashof (Gr)} = \frac{gL^3}{\nu^2} \times \beta\theta$$

$$\text{Nusselt (Nu)} = \frac{hL}{k}$$

$$\text{Péclet (Pé)} = \frac{VL}{\alpha}$$

$$\text{Prandtl (Pr)} = \frac{\nu}{\alpha}$$

$$\text{Reynolds (Re)} = \frac{VL}{\nu}$$

$$\text{Stanton (St)} = \frac{h}{C_p\rho V}$$

$$\text{Graetz (Gz)} = \frac{\pi}{4} \text{ Pé } \frac{D_t}{L}$$

By virtue of the similarity in units there are also many relationships between the groups. Among these are:

$$\text{Pé} = \text{Re} \times \text{Pr}$$
$$\text{Nu} = \text{St} \times \text{Re} \times \text{Pr}$$
$$\text{Nu} = \text{St} \times \text{Pé}$$

A further examination of these groups shows that they have a significance within themselves which accounts for the variety of uses to which they are applied.

For steady state transfer *Nu* can

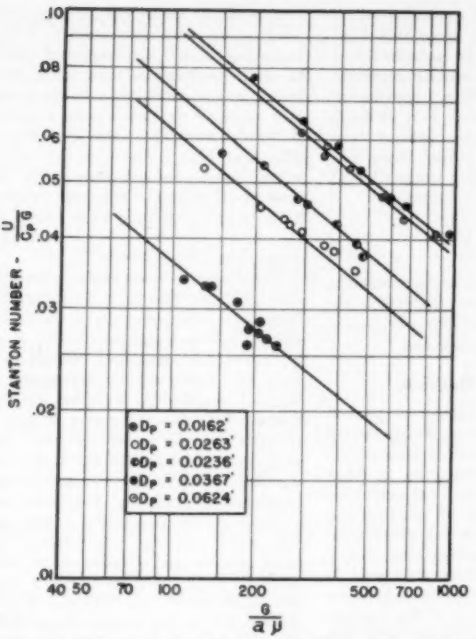

Figure 3. Heat Transfer in the 2-Inch Chamber While Heating the Gas.

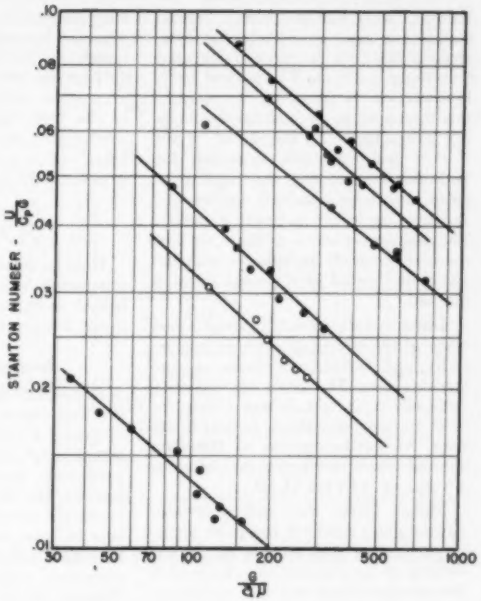

Figure 4. Heat Transfer in the 4-Inch Chamber While Heating the Gas.

often be a deciding parameter. If the concept of film resistance is adhered to, the group may be looked upon as the ratio of an arbitrary characteristic length L to the film thickness.

The significance of the Stanton group becomes immediately evident if both numerator and denominator are multiplied by Δt. It then becomes the ratio of the heat actually transferred per unit area and per unit time to the amount that could be transferred if the temperature differential ultimately became zero.

Either one of these groups will normally occur in a heat transfer equation, but the one giving best results depends somewhat on the situation. Since the Stanton group contains a flow term, it would seem to give better results where the flow was a variable. One of the first and most widely known uses of dimensional analysis was by Dittus and Boelter[26] who determined the constants of the equation

$$Nu = a\,Re^{b}\,Pr^{c} \qquad (1)$$

This equation can be shown in alternate form as

$$St = a\,Re^{b-1}\,Pr^{c-1} \qquad (2)$$

by using the relationships between the groups.

The same type of analysis may be applied to packed beds except that the definition of the individual terms is not quite so simple. For an empty pipe the obvious linear dimension is the inside diameter, whereas both the particle diameter and chamber diameter are linear factors when packing is present. An analogous situation develops with the area terms and other properties of the system. As a consequence, the approach of many investigators has followed the framework set up by Equation 1 and 2, but they differ in their handling and definition of the different individual terms such as thermal conductivity, film coefficient, mass flow rates, etc.

The Use of the Stanton Group. One of the first and best known works in the field was done by Colburn[5] who defined a j_h factor as a function of the Stanton and Prandtl numbers. For packed beds j_h was defined by

$$j_h = \left(\frac{h}{C_p G}\right)\left(\frac{C_p \mu}{k}\right)^{2/3} \qquad (3)$$

This value of j_h was plotted versus a modified Reynolds number to give a good correlation on the data studied. He proposed the superiority of this correlation over that using Nu on the basis that with the latter a function was plotted against itself. In later work[6] wet air was passed through beds of spherical and cylindrical solids, which resulted in the relationships

For laminar flow $Re < 40$

$$j_h = 18.1\left(\frac{D_p G}{\mu}\right)^{-0.81} \qquad (4)$$

For turbulent flow $Re > 350$

$$j_h = 1.064\left(\frac{D_p G}{\mu}\right)^{-0.41} \qquad (5)$$

A single curve was obtained for both flow regions with a sharp break in the transition region between laminar and turbulent flow.

A j transfer factor for diffusion has also been developed (j_d) and has been correlated with respect to the function $6G/a\mu$ by many investigators. Gamson[7] has extended this work to heat transfer by using the modified Reynolds number $6G/a\mu$. The term $6G/a\mu$ is actually a modified Reynolds number obtained by transforming the particle diameter for a sphere to specific surface by means of the expression:

$$D_p = 6\left(\frac{1 - f_t}{a}\right) \qquad (6)$$

The void volume of the system was the parameter and separate curves were obtained for each shape of particle. In order to get all curves to coincide he also introduced an arbitrary shape factor into the denominator of the modified Reynolds number.

A slightly different modified Re has also been proposed[19] which takes the form

$$Re = G\sqrt{Ap}/\mu.$$

Coberly and Marshall[2] use this form of the group in a correlation on a limited system.

The Use of the Nusselt Group. The Nusselt Group has also been a logical choice for use in correlating data, since it has been so successfully used for empty conduits. For packed beds, however, it is necessary to modify this treatment to account for the packing properties. The Bureau of Mines [12, 13, 14] has used this approach for both the heating and the cooling of gases, and have obtained correlations for tubes up to two inches in diameter. The original work was done on low thermal conductivity spheres with the gas being heated as it passed through the bed.

These investigators also determined some of the effects of particle conductivity and surface roughness on the transfer rate. The latter showed very little effect; in fact, it was within the 8-10 percent deviation found in all data. An examination of the data showed that h attained a maximum at a value of 0.15 for D_p/D_t.

Shapes other than spherical also gave slightly different results so a correction factor was introduced. It was defined as the ratio of the observed to the calculated heat transfer coefficient, and was used to correct for both particle shape and conductivity. There was some tendency for the higher conductivity packings to show a slightly larger transfer rate. However, the higher values were also within the limit of experimental error. Even though no chambers larger than two inches were run, the values of h were extrapolated to six inch diameters. Such a procedure is open to question, particularly with a packing that has a rather large D_p/D_t ratio in the two-inch tube.

In order to determine the heat transfer effects with very large particle-tube ratios, Leva[15] performed some work on large packings. The correlation here was not so exact since a plot of $\frac{hD_t}{k_e}$ vs. $\frac{D_pG}{\mu}$ did not give the essentially parallel lines experienced with the smaller packings.

Other Empirical Correlations. Other empirical works of note have been done by European investigators, particularly Verschoor and Schuit.[20] They studied the heat transfer from the wall of a packed tube to the fluid flowing through it. In doing this they made use of an effective packed bed thermal conductivity (k_p) defined as "the thermal conductivity of a hypothetical fluid flowing through an empty tube at the same over-all linear velocity as the real fluid, and showing equal inlet and outlet temperatures." The modified Reynolds number of Carman was used and they found equations which were general in the sense that they were not limited to the turbulent flow region. As the fluid velocity decreases the heat transfer coefficient approaches a constant value which is a measure of the free convection transfer. The conductivity may be found from Wilhelm[23] or in a porosity range of 0.35 to 0.45 by the approximation

$$\frac{k_p^\circ}{k_e} = 1.72\left(\frac{k_s}{k_e}\right)^{0.28} \qquad (7)$$

These relationships are particularly interesting because they furnish a potential means of predicting cross-sectional temperature gradients.

Analytical Methods

An analytical solution of packed bed heat transfer offers the advantage of giving a more detailed view of the actual mechanisms involved. It finds particular application with catalytic reactors for the heat of reaction can be easily included in the differential heat balance, the starting point in any analytical solution. Since this work is concerned with the bed as a heat exchanger, no discussion of the reaction heats is included. However, the differential balances may be corrected very easily for catalytic beds by the simple addition of a heat of reaction term. Wilhelm and Singer[24] have written such an equation in terms of a radius, an axial distance and the angular position.

Damköhler, in a series of articles[4,5] developed analytical approaches such as that above by deriving the vector equations for the conservation of mass momentum and energy. With Delker, he also did fundamental work on axial temperature gradients in catalytic converters.

Although they are specific for given reactions, a number of works with regard to catalytic converters have been published. For the most part they place primary emphasis upon the prediction of temperatures, using effective thermal conductivities in conjunction with analytical solutions.

The word effective is used, for included are the radiation effects. Damköhler calculated this effect by modifying the Stefan-Boltzman equation. No data are given in support of his equation but it gives results which appear to be reasonable.

A very ingenious electrical network has been used by Wilhelm et al.[23] to determine transfer characteristics in catalytic converters. Since these are both rate processes, they used a series of variable resistances in series and parallel to represent the packed bed flow patterns. The work reported is of a preliminary nature but some thermal conductivity data attributed to Schumann and Voss[18] are improved upon. In their correlation these men neglected any conductivity which arose as a result of the solids point contact. Wilhelm examined a large quantity of data and found that the Schumann values should be corrected. By the method of residuals and least squares he obtained a residual to be added to the conductivities of Schumann and Voss, shown by Wilhelm.

The prediction of radial temperature gradients has been developed by Grossman[8] who writes the fundamental energy balances and then solves them by successive graphical integrations over reasonably small increments. A heat of reaction is included but the method has general interest in that it eliminates the series solution. The same general approach has been used by Hall and Smith[9] in determining temperature gradients, but their correlation is for a specific system and has little general application. For their system an effective k of 0.20 Btu-foot per hour square foot-°F. was obtained. Hurt[11] and Wilhelm et al.[22] have made further investigations along these lines which are of particular specific interest in catalytic reactors using fixed bed catalysts.

Other works have been done by Arthur and Linnett[1] and Huntington et al.[10] in an attempt to predict temperature gradients.

Schumann[17] has also solved some balances for flow through a porous prism which are similar to packed beds, and are very similar to some discussed above.

The work of Waddams[21] is interesting for he has investigated packing thermal conductivity very carefully and reported it for various metallic spheres and calcite granules. The values, however, are just listed and no correlation is attempted.

Saunders and Ford[16] have made a very thorough investigation of packings with regard to their application in the steel industry. This work is primarily concerned with the unsteady aspects of heat transfer and the point temperatures to be expected as the bed heats up. Pressure drop and heat transfer coefficient correlations are also presented.

Experimental Work

A number of packing schemes were tried which gave widely varying packing characteristics until it was decided to use a procedure comparable with that normally encountered in industrial units. The material was poured very slowly into the chamber, accom-

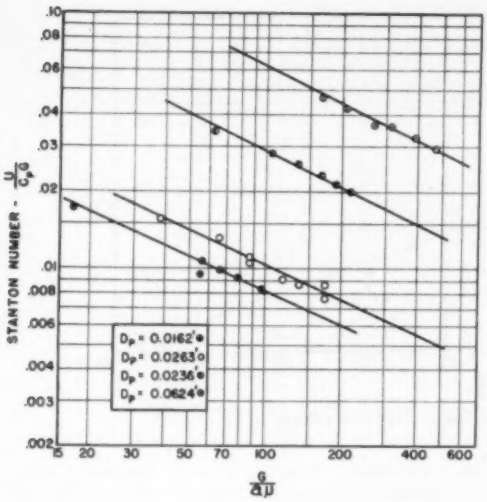

Figure 5. Heat Transfer in the 6-Inch Chamber While Heating the Gas.

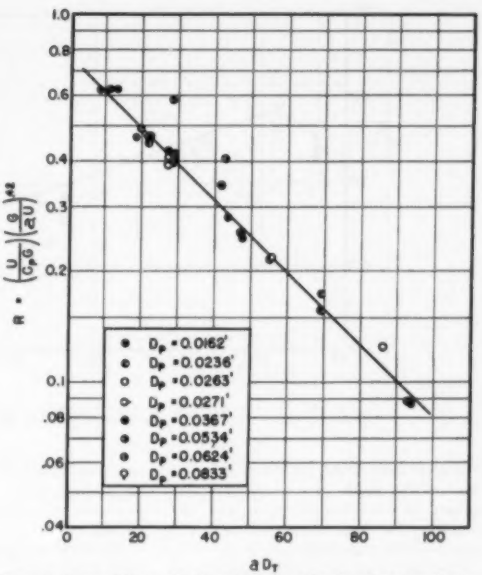

Figure 6. Factor "R" vs. the Particle Area—Chamber Diameter Factor.

panied by periodic light taps of a hammer on the sides in order to help align the packing. The resultant arrangement, which might be called of medium density with regard to porosity, settled very little during the course of a run indicating that it was reasonably stable. The packing characteristics shown in Part I were obtained in this manner and are the result of three check measurements. Data such as specific heat and thermal conductivity were obtained from the manufacturer. The dimensions of the particles were determined on not less than lots of 50 selected at random from the screened commercial packing. A micrometer was used for all measurements, with three diameters being taken on the spheres, and two diameters and a length on the cylinders. These readings were then averaged.

Natural gas from the mains of Oklahoma Natural Gas Company was used as the fluid in all cases except for a few runs made with air.

The composition of this gas varied with the field source since they were injecting air to keep the heat content substantially constant. The specific gravity varied from 0.58 to 0.76 over a period of time although it was substantially constant during any one run. A continuous record of the gravities was obtained with an AC-Me recording gravitometer. Low temperature analyses were made periodically and a typical one is shown in Table 1.

In light of the variation in fluid properties it was necessary to compute densities, specific heats and thermal conductivities for the range encountered. This was done on the basis of the composition obtained by the above-mentioned fractional analyses. These values were checked with the limited existing data and agreed very well. Although a pressure correction was made it had little effect since the system pressure seldom went above 10 psi. As later figures will show, this variation in gas properties had no noticeable effect on the correlation of results and, in one sense, was advantageous in that it helped point out that heat transfer phenomena were relatively insensitive to this change.

An analysis of the procedures showed a maximum potential error of 9-10 percent. An examination of the data shows them to be easily within this limit.

Discussion of Results

The data have been analyzed to produce correlations which utilize process specification information as much as possible. The use of arbitrary constants has been minimized because their values are quite often not readily available. The data were first correlated in terms of over-all heat transfer coefficients. Such a correlation is purely empirical and adds little to fundamental knowledge, but is expedient for use in process design calculations. Empirical coefficients are particularly applicable where heat has to be removed or added through the wall of a catalytic system. Following this attack a detailed analysis of the temperature gradients in the packing proper was made not only for their prediction in beds of other dimensions, but to examine further the mechanisms of transfer. Wall surface film coefficients have also been calculated in order to determine the heat transfer characteristics in the vicinity of the wall. Finally, special data are shown which clarify the mechanisms involved. For convenience these various topics are discussed separately.

TABLE 1
A Typical Analysis of the Natural Gas

Component	Volume Percent
CO_2	0.70
N_2	1.95
CH_4	82.50
C_2H_6	8.20
C_3H_8	3.67
C_4H_{10}	1.86
C_5H_{12}	.72
C_6H_{14}	.19
C_7H_{16}	.11

Specific Gravity—0.693
Gross Heating Value—1183.53 Btu. per cubic foot
NOTE: During certain periods the gas contained as high as 3 percent oxygen and 13 percent nitrogen.

Over-All Heat Transfer Coefficients

An over-all heat transfer coefficient is particularly useful for those engineering calculations which must be made in the design of a new packed bed reactor. Such systems usually involve the transfer of heat to the fluid, although there are some applications

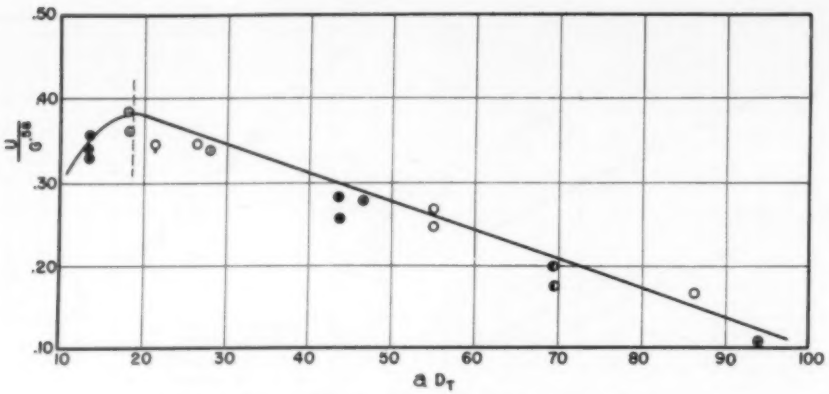

Figure 7. Variation of the Over-all Heat Transfer Coefficient with a D_t.

in which heat must be removed. For this reason, both processes were examined to see what effect, if any, the direction of heat flow had on the over-all heat transfer coefficient.

The use of dimensional analysis in the flow of heat shows that a relationship exists between the various dimensionless groups for flow through an empty tube. Only two of the groups, the Stanton and Nusselt numbers, contain a heat transfer coefficient; hence, any correlation should contain one of them. Also, it has been established that the transfer is some function of fluid flow rate, and this is most conveniently expressed in dimensionless form by a function of Reynolds number.

Correlation of Data. A preliminary examination of the data from this investigation revealed that either Equation (1) or (2) offered a potential correlation if it were properly modified to include some particle specifications. This result was expected, for such an approach has been successful in the past on some systems that have been studied. The most common Reynolds number has been D_pG/μ, where D_p is an equivalent particle diameter. It has been customary to use D_p/D_t as a parameter. However, an examination of the data obtained here showed that the transfer was primarily due to convection, and this introduces the film concept which, in turn, depends on surface area. It was therefore felt that any general correlation should include an area term. A modified Reynolds number of the form $G/a\mu$ satisfies this condition, where a is the surface area of the packing material per cubic foot of bed. The Stanton group was chosen instead of Nusselt group because the latter is related to Reynolds number and any correlation would include this variable on ordinate and abscissa. Such a procedure then might lead to a misleading appearance of correlation where none existed.

The Stanton group has been written as U/C_pG, where U is an over-all coefficient based on the inside tube wall area and the temperature difference between the center of the bed and the tube wall. On the basis of Equation (2), the Stanton group was plotted versus the modified Reynolds number on log-log paper. These plots are shown in Figures 1 through 5 for both the cooling and the heating of gas in the 2, 4 and 6-inch diameter chambers. The lines are straight, which verifies the dimensional analysis. They are also substantially parallel and have about the same slope regardless of chamber and particle size. The following equations of the lines may be written

For cooling, $Re > 30$

$$\frac{U}{C_pG} = R_c\left(\frac{G}{a\mu}\right)^{-0.42} \qquad (8)$$

For heating, $Re > 30$

$$\frac{U}{C_pG} = R_h\left(\frac{G}{a\mu}\right)^{-0.42} \qquad (9)$$

where R_c and R_h are proportionality constants.

The powers to the respective Reynolds numbers are raised represent the average slopes of the lines for each case. However, the difference in the effect of the powers is about three percent which is less than the accuracy of the data. It is therefore evident that the direction of heat flow has little effect on the amount of heat transferred. Equation (8) is then recommended for both cases and will be used in subsequent discussions. The symbol R, without subscript, will also be used for both cases.

TABLE 2
List of the Packing Materials Investigated

Material	Bp-ft.	Symbol Used in Figures
Silica-Alumina Cylinders	0.0162	●
Hydrated Alumina Cylinders	0.0263	○
Tabular Alumina Spheres	0.0236	◐
Aluminum Cylinders	0.0271	◇
Tabular Alumina Spheres	0.0367	◆
Aluminum Cylinders	0.0534	◉
Glass Spheres	0.0624	⊙
Glass Spheres	0.0833	♀

NOTE: For a complete tabulation of the properties of the above packing materials, see Table 1, Part I of this article.

Rearrangement of Equation (8) gives

$$\left(\frac{U}{C_pG}\right)\left(\frac{G}{a\mu}\right)^{0.42} = R \qquad (10)$$

An examination of the left hand terms shows that for a given gas at a given set of conditions, U and R depend only on a. However, from Figures 1 through 5 it is seen that U varies with chamber diameter when all other variables are held constant. Therefore, R should be some function of aD_t. Figure 6 is a semi-log plot of R vs. aD_t for all the packings. The resultant points form an excellent straight line, the equation of which is

$$\ln R = \ln 0.76 - 0.0225\, aD_t \qquad (11)$$

Rearranging

$$\frac{U}{C_pG} = 0.76e^{-0.0225\,aD_t}\left(\frac{G}{a\mu}\right)^{-0.42}$$

It is interesting to note that Equation 11 is similar to that obtained by Colburn and others [2, 6] except that it has an additional term involving e raised to a negative power. This term resulted from the variation of chamber diameter and shows that chamber size has an effect on the heat transfer coefficient. In the references cited above, only one chamber diameter was used.

Effect of the Prandtl Group. Equation (11) does not contain the Prandtl group which is indicated by analogy

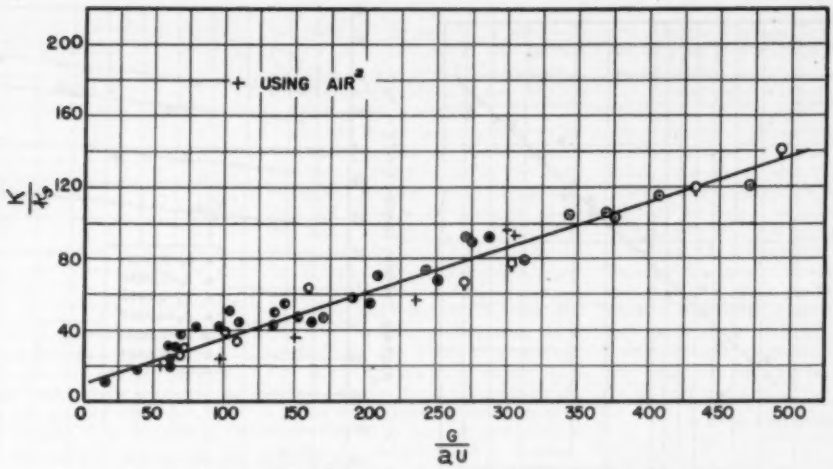

Figure 8. Over-all Thermal Conductivity as a Function of the Modified Reynolds Number.

with the flow through empty tubes. Natural gas, ranging in specific gravity from 0.58 to 0.76 was the fluid used, but even with this spread the Prandtl number was substantially constant. It thus seems valid to propose Equation (11) as a correlation for any gas as long as the value of the Prandtl group is near 0.80. This would include all the gases normally employed in such systems.

Optimum Over-all Heat Transfer Coefficient. Separation of the variables in Equation 11 along with rearrangement, gives

$$U = 0.76\, C_p a^{-.42}\, \mu^{.42}\, G^{.58}\, e^{-.0825 a D_t}\, a D_t \quad (12)$$

This equation shows that the coefficient U increases with an increase in mass velocity, but decreases as the value aD_t becomes larger. This indicates that there is some point at which U should reach a maximum. Equation 12 may be differentiated with respect to a with D_t held constant.

$$\left(\frac{\partial U}{\partial a}\right)(D_t) = 0.76\, C_p \mu^{.42} G^{.58} e^{-.0825 a D_t} a D_t\, (0.42 a^{-.58}) - 0.76\, C_p \mu^{.42} G^{.58} a^{.42}\, e^{-.0825 a D_t} a D_t\, (0.225 D_t) \quad (13)$$

Equating Equation (13) to zero and cancelling out like terms

$$0.42 a^{-.58} = .0225 a^{.42} D_t \quad (14)$$

or

$$(aD_t)_{t\text{-max.}} = 18.7$$

Figure 7 is a plot of the data with $U/G^{.58}$ vs. aD_t.

The curve goes through a maximum at about 18.7 which further verifies Equations (11) and (12).

It is also of interest to note that these equations contain no terms involving the properties of the packing itself except surface area. The successful correlation of the data in terms of a convection coefficient, without other packing property terms, implies that convection is primarily responsible for the transfer. In Figure 7 it can be seen that the only two points which fall substantially above the correlation represent aluminum cylinders having a relatively high thermal conductivity. These points have no significance with regard to a higher heat transfer due to packing properties, for other aluminum points lie on the line. Rather, these points seem to indicate experimental error.

Over-All Packing Thermal Conductivity

The over-all heat transfer coefficient is a readily useable tool for predicting heat transfer but does not aid in the prediction of temperature gradients. An over-all differential heat balance for a packed system yields

$$\frac{\partial t}{\partial x} = \frac{K}{C_p G}\left(\frac{\partial^2 t}{\partial r^2} + \frac{1}{r}\frac{\partial t}{\partial r} + \frac{\partial^2 t}{\partial x^2}\right) \quad (15)$$

where x = depth of packing—feet.
t = temperature—°F.
r = distance from the center of the bed—feet.
C_p = specific heat of the gas—$\frac{\text{Btu.}}{\text{lb. °F.}}$
G = mass velocity of the gas—$\frac{\text{lb.}}{\text{hr. ft.}^2}$
K = effective over-all thermal conductivity of the gas and packing.

Temperature gradients were obtained in both the radial and axial directions. Axial gradients were taken along the center line of the chamber. The radial gradients were obtained five feet below the gas inlet to eliminate entrance effect. These gradients were taken for both the heating and the cooling cases.

Examination of the axial gradients showed that the last term on the right side of Equation 15 made a negligible contribution to the value of K. Also, $\partial t/\partial r = 0$ on the center line of the chamber; hence

$$\lim_{r \to 0} \frac{1}{r}\frac{\partial t}{\partial r} = \frac{\partial^2 t}{\partial r^2} \quad (16)$$

and Equation (15) may be modified to

$$K = -\frac{1}{2}\,\frac{C_p G \dfrac{\partial t}{\partial x}}{\dfrac{\partial^2 t}{\partial x^2}} \quad (17)$$

Equation (17) was used to determine values of K by drawing the experimental temperature gradients and taking the proper differentials.

These values of K increased with mass velocity, and it was evident, as expected, that gas flow rate was a factor. Since particle surface area was probably a factor, the modified Reynolds number used previously was arbitrarily chosen as a variable. A plot of K versus this dimensionless group gave a satisfactory correlation for natural gas but failed to agree with the results obtained by other investigators with air for similar packing materials.[2] It was then evident that the thermal conductivity of the gas itself was a factor. The data were replotted as $\frac{K}{k_g}$ versus the Reynolds group, where k_g is the average thermal conductivity of the gas. This plot is shown in Figure 8. This figure not only gives a satisfactory correlation for natural gas but shows a satisfac-

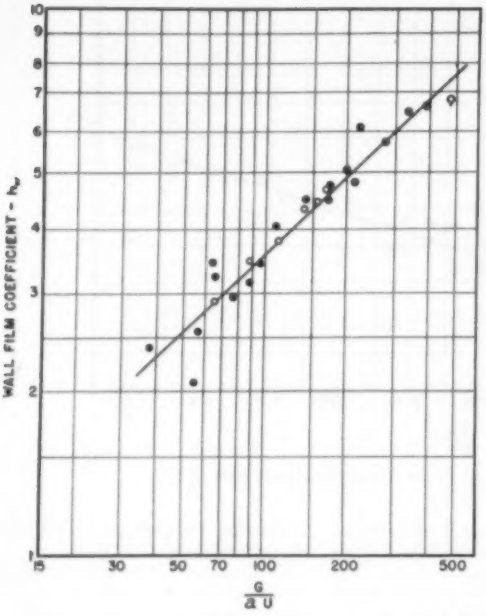

Figure 9. Wall Film Heat Transfer Coefficient as a Function of the Modified Reynolds Number.

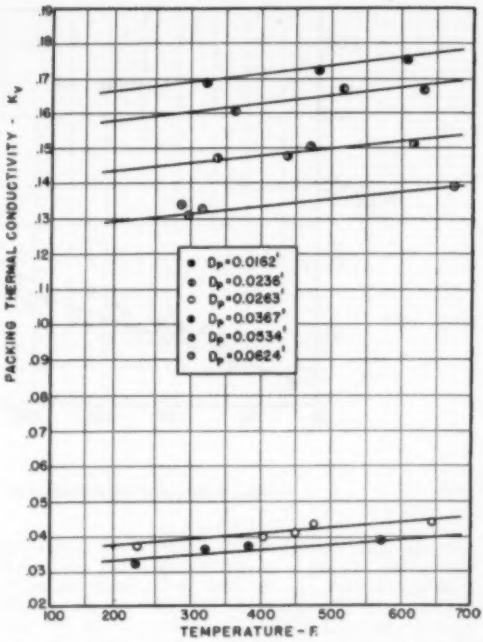

Figure 10. Variation of the Effective Packing Thermal Conductivity with Temperature, in a Vacuum.

tory agreement with the above-mentioned data for air. The equation of the line is

$$\frac{K}{k_g} = 10.0 + 0.267\left(\frac{G}{a\mu}\right) \qquad (18)$$

In light of the agreement of this equation for both air and various natural gases, it is proposed as a satisfactory correlation for the over-all packed bed effective thermal conductivity. The value of K may be used to predict temperature gradients in systems containing spherical or cylindrical particles.

The correlation of the data by Equation (18) is particularly good when the errors in taking the first and second derivatives graphically are considered. There is a minimum probable error of about 20 percent in this operation alone, without regard to other factors.

The correlation of the conductivity is interesting for, as with the heat transfer coefficient, neither the thermal conductivity nor the specific heat of the packing proper is involved. This is further evidence that conduction from particle to particle by direct contact is of negligible significance.

In some respects U and K are related quantities. Their units are different but they are both a measure of the total heat transfer. The former value, however, includes any resistance to transfer at the wall, whereas the latter involves only resistance in the packed bed.

Wall Film Heat Transfer Coefficient

By the use of the proper boundary conditions, Equation (15) may be integrated to give the temperature at any point in the bed.[2] The integrated equation then may be used to calculate the equivalent resistance of the wall in terms of a wall film heat transfer coefficient, h_w. The following boundary conditions apply:

At center of chamber:

At $r = 0$ $\partial t/\partial r = 0$ for all values of x.

At the inlet:

At $x = 0$ $t = t_o$ for all values of r, since the temperature is uniform at that point.

At the wall:

$$\text{At } r = R - K\left(\frac{\partial t}{\partial r}\right)_R = h_w\,(t_w - t_R)$$

where R = inside radius of chamber—feet,

h_w = wall film heat transfer coefficient—Btu./hr. ft.^{2} °F.

t_R = gas temperature at $r = R$.

t_o = inlet temperature of the gas.

Equation (15) is readily integrated, using these boundary conditions, if G is assumed to be constant across the diameter of the tube. There are sufficient data to justify this assumption.

The data were examined in accordance with the integrated equations to find values of h_w for the various materials at different gas flow rates. Figure 9 is a plot of these results versus the modified Reynolds number used previously. The points obtained are best represented by the equation

$$h_w = 0.42\left(\frac{G}{a\mu}\right)^{0.67} \qquad (19)$$

This wall film coefficient is primarily of academic interest although it could be used in conjunction with the over-all thermal conductivity K in design. It is a function of chamber diameter, but the direction of heat flow has no apparent effect on its value.

Chamber diameter is a significant variable. With a given size of packing, an increase in chamber size lowers the over-all fraction voids and thus reduces the fraction of gas flowing adjacent to the wall. This effect is reflected in changes in the value of a.

A quantitative comparison of h_w with K is difficult because of the errors inherent in their values and the fact that the value of one depends on the other. However, a qualitative comparison throws light on the general mechanism of transfer. For a given diameter chamber, the particle size and the mass velocity are the key variables. With mass velocities rang-

ing from 279 to 910, typical relationships were obtained as shown in Table A.

TABLE A

MATERIAL	$\frac{h_w}{KR}$
¼" x ¼" Silica Alumina Cylinder	10.5-15.2
¼" x ¼" Hydrated Alumina Cylinders	10.0-11.8
¼" Tabular Alumina Spheres	9.0-11.1
⅛" Aluminum Cylinders	8.9-11.6
⅛" Glass Spheres	9.6-13.2
1" Glass Spheres	6.4- 9.4

The increase in the value of the ratio $\frac{h_w}{KR}$ corresponds to decreasing values of the mass velocity. The tabulation shows that the equivalent coefficient h_w for the wall is about ten times that for the packing KR, and it is obvious that the packing offers the main resistance to flow. It is interesting to note that the thermal conductivity of the particles has little effect on the relative resistances.

In spite of the relatively greater resistance of the packing, it makes the over-all coefficient much greater than that of an empty tube. At the same mass velocity the over-all U in an empty tube is approximately 2.0 Btu./hr.-ft. 2° F. The h_w values observed in this work are from two to sixteen times greater, depending on the dimensions of the system. It is apparent then, from the above tabulation, that the packing introduces higher velocities and greater turbulence in the vicinity of the wall.

Effect of Particle Characteristics on Heat Transfer

The results prove that the transfer of heat in a packed bed is largely by convection. Aluminum has about 200 times the conductivity of porous alumina, yet packings made of these materials have the same over-all coefficients. Therefore, the temperature gradients across the packing were measured in an evacuated chamber. In this manner the heat transfer was limited to radiation and conduction. A summary of the results is shown in Figure 10. Although the particle diameter D_p was used, for convenience, to differentiate between the lines, it is not the only variable.

The two lower lines represent cylinders having a relatively small diameter. However, spheres of about the same equivalent diameter and thermal conductivity show a conductance about four times as high ($D_p = .0236$). This difference is logically explained by the fact that the spheres have a higher percentage voids, and radiation becomes an appreciable factor. The top two lines are for spheres having the same conductivity, but different diameters. The larger particle size results in a higher effective thermal conductivity, K_v. The larger spheres, however, have fewer points of contact for a given cross-section, which tends to decrease the contribution of conduction to the over-all K_v.

Figure 10 shows that the aluminum cylinders ($D_p = 0.0534$) have no increased value of K_v over alumina packing of the same shape and size having a thermal conductivity only 1/200 as great. It is likely that the actual conduction is somewhat higher with aluminum. However, it has a radiation emissivity only about a fourth that of the aluminas, and this compensates for the higher conductivity and gives about the same over-all K_v. Even the highest values of K_v, however, are small, and conduction contributes little to the total transfer.

Extrapolation of the curve for K (Figure 8) to zero mass velocity, G, gave a value of 0.31. The conductivity of the gas, k_g, seldom exceeded 0.03 while that of the packed bed was never greater than 0.18. Thus, free convection accounts for about 50 percent of the total heat transfer at zero mass velocity. As the mass velocity assumes finite values, the value of K increases. At the highest Reynolds number, less than four percent of the heat was transferred by radiation and conduction. At the average flow rate about ten percent was transferred by these mechanisms.

A special spherical particle was then constructed of porcelain cement, having a thermocouple at the center, another just inside the surface, and a third adjacent to the surface. This particle was inserted into the bed and allowed to come to equilibrium at various flow rates and temperatures. In every case, the temperature differential between the successive couples never exceeded 1° F. Such gradients are too small to be handled quantitatively, but they confirm the hypothesis that, on a relative basis, conduction and radiation contribute little to the total transfer of heat in the bed.

ACKNOWLEDGMENT

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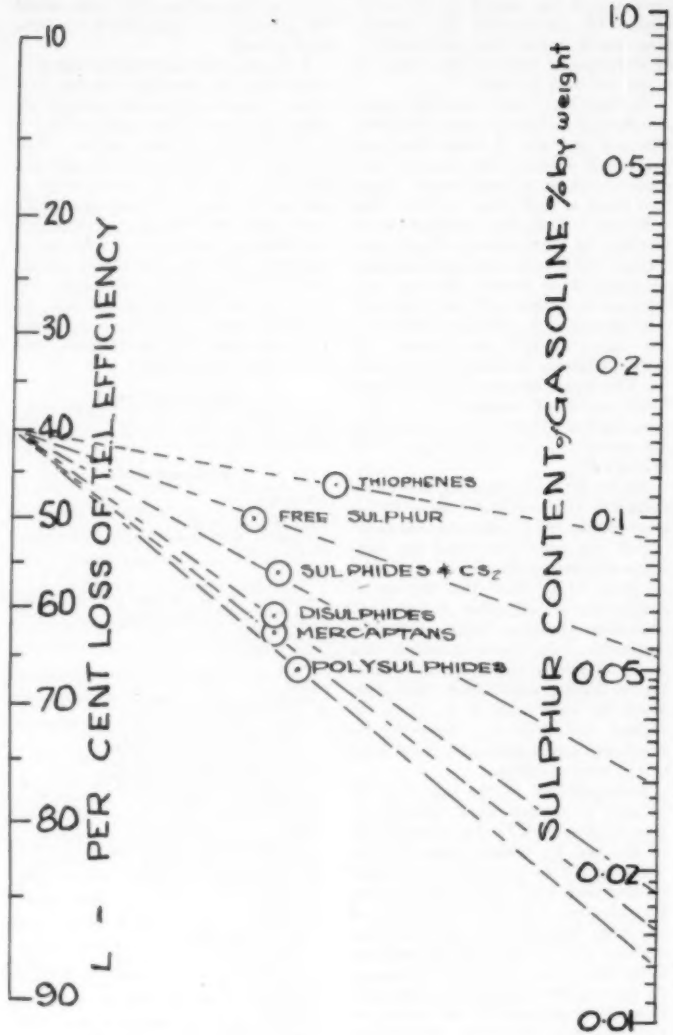
NOTE—This Table 1, Packing Material Specifications, with corrected column headings is being repeated. It originally appeared in Part 1 on page 130 in the December issue.

	Chamber Diameter	Silica Alumina	Hydrated Alumina	Tabular Alumina	Aluminum	Tabular Alumina	Aluminum	Glass	Glass
Shape	...	Cylinder	Cylinder	Sphere	Cylinder	Sphere	Cylinder	Sphere	Sphere
Dimensions—Inches	...	0.155r 0.155	0.258r 0.264	0.282	0.253r 0.291	0.440	0.501r 0.533	0.75	1.0
D_p*	...	0.0162	0.0263	.0236	.0271	.0367	0.0534	.0634	.0833
Thermal Conductivity*	...	0.62†	0.63†	1.8†	117	1.8†	117	0.63	0.63
Heat Capacity-C_p	...	0.23	0.23	0.20	0.21	0.20	0.21	0.20	0.20
No. of part. per ft.^{3}	2"	331,000	70,900	71,900	67,400	18,200	8810	3900	1600
No. of part. per ft.^{3}	4"	344,000	76,000	74,000	67,000	19,600	9070	4480	1810
No. of part. per ft.^{3}	6"	349,000	78,600	78,700	70,900	20,450	10,150	4540	1910
Surf. Area per ft.^{3}	2"	270	153	125	155	76.4	74.9	47.6	34.9
Surf. Area per ft.^{3}	4"	280	164	129	154	82.3	84.8	54.7	39.4
Surf. Area per ft.^{3}	6"	284	170	137	163	85.9	96.3	55.4	41.7
Packed Dens. lb./ft.^{3}	2"	38.3	51.3	121	93.1	115	87.4	76.4	74.8
Packed Dens. lb./ft.^{3}	4"	39.8	55.0	126	96.5	125	98.8	87.5	84.2
Packed Dens. lb./ft.^{3}	6"	40.4	56.1	132	97.6	130	101	88.9	89.1
Absolute Dens. lb./ft.^{3}	...	94	92.7	245	163	245	163	144	154
Percent Voids	2"	40.1	44.6	50.6	43.3	53.0	46.4	50.4	51.5
Percent Voids	4"	37.7	40.6	49.1	42.9	49.1	39.4	43.2	45.4
Percent Voids	6"	36.8	38.5	45.9	40.1	47.0	38.1	42.3	42.1

* Equivalent diameter $(D_p) = \left(D_c H_c + \frac{D_p^2}{2}\right)^{1/4}$ for cylinders

† Estimated
°Btu. — ft. per ft.^{2} — °F. — hr.



Nomograph for Influence of Sulfur Compounds on T.E.L. Efficiency

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THE PROBLEM of the quantitative effect of the presence of sulfur compounds on the octane number of leaded gasolines has attracted the attention of many workers. Livingstone[1, 2, 3] has extended and correlated these data and has suggested a possible mechanism for the inhibiting effect which can be expressed quantitatively.[3]

$$\frac{L}{100-L} = KC^n$$

Where L = percentage loss in lead efficiency
C = concentration of sulfur compound as percent sulfur by weight

K and n are constants.

This relationship has been shown to hold for different base stocks of 40 to 95 O.N. containing up to 6.0 ml TEL per gallon, and not more than 70 percent naphthenic or aromatic hydrocarbon or 2 percent sulfur. The octane rating may be determined by either the Motor or Research method.[3]

The nomograph presented here conveniently solves this relationship for various classes of sulfur compounds. The data for mercaptans, disulfides and thiophenes are taken from[3] and for free sulfur from.[1] The point on the chart for polysulfides was derived from Ryan's data for dibutyl tri- and tetra-sulfides[4] and Livingston's data for diethyl tetrasulfide.[1] Data from the author's laboratory indicate that the effect of carbon disulfide approximates that of the sulfides.

Use of Chart

To use the chart connect by means of a straight edge, the concentration of the sulfur compound expressed as percent sulfur by weight in the gasoline, with the point for that class of compound and extend to the left hand (L) scale to give the percentage loss of TEL efficiency. Thus 0.0155 percent mercaptan sulfur will cause a loss of 40 percent of lead efficiency, i.e., L = 40. Similarly 0.090 percent thiophene sulfur, 0.053 percent free sulfur, 0.030 percent sulfide sulfur, 0.018 percent disulfide sulfur or 0.013 percent polysulfide sulfur will give the same value of L=40.

The effect of different sulfur compounds is additive so the loss of lead efficiency can be predicted if the amount of sulfur in each type of chemical combination (i.e., mercaptan, sulfide, thiophene, etc.) is known. Livingston[3] described the method of calculation which is greatly simplified by the use of this nomograph. The first step is to convert the concentrations

of all the different classes of sulfur compounds to an equivalent basis which may be conveniently taken as the equivalent concentration of one particular class of compound. In the example given previously the different concentrations of the various sulfur compounds taken were all equivalent and it indicates the method to be used. Thus the L value is estimated from the nomograph as before and the equivalent concentration of the standard class of sulfur compound determined which will give the same L value by connecting that value of L with the point for the compound by means of a straight edge and extending to cut the concentration axis. For convenience, reduce the sulfur concentrations to the equivalent of either sulfide, disulfide or mercaptan sulfur. It is advisable to standardize on one of these classes as, although the relative sulfur antagonism does differ for the other classes, these differences disappear when the results are corrected for the effect of the sulfur dioxide in the residual burned gases in the fuel-air mixture.[5]

Example·

Class of Sulfur Compound	Concentration Percent S by Weight	Equivalent Percent S as R_2S
Thiophene	0.090	0.030
Sulfide	0.010	0.010
Disulfide	0.018	0.030
Total	0.118	0.070

For 0.070 percent sulfide sulfur L = 55.

Calculation of Effect of Desulfurization

If the lead susceptibility of the sulfur free base stock can be determined or calculated it is possible to calculate the effect of sulfur removal.

Example:

A gasoline sample contains 0.015 percent mercaptan sulfur. The TEL efficiency loss, L, is 55 percent. What will be the effect of complete removal of the mercaptans? A value of L = 55 would be given by 0.037 percent mercaptan sulfur. Removal of 0.015 percent mercaptan sulfur leaves 0.022 percent for which L = 47. In 60 O.N. reference fuel this would correspond to approximately 1½ O.N.

Accuracy

The accuracy of the nomograph is naturally limited to the accuracy of the data on which it is based, that is the accuracy of the relationship deduced by Livingston. In general the accuracy of the L values increases as the TEL concentration is increased to about 3 ml per gallon after which it decreases; L increases as the octane number of the base stock decreases,[2] and also as the total efficiency loss increases. However, an average estimate of the accuracy of ±5 percent can be taken with a reasonable degree of confidence though, in extreme cases, it ranges between ±1 percent and ±12 percent for an accuracy of 0.5 O.N.

Stationary Test Diesel Locomotive

A Shell engineer examines the inner workings of a 600-horsepower diesel locomotive used for testing fuels and lubricants at Shell Oil Company's Martinez Research Laboratory.

A STATIONARY test diesel locomotive engine has "traveled" the equivalent of more than 120,000 miles, according to officials of Shell Oil Company at Martinez (Calif.) Research Laboratory. Designed to test lubricants and fuels, it dwarfs other automobile and industrial engines located in adjacent rooms and is exactly the same engine as those in standard switching locomotives. The six-cylinder, 600-horsepower diesel engine, which is mounted on a concrete and steel base, has operated more than 3000 hours—or the equivalent of 40 trips between San Francisco and New York.

The installation of the big testing engine at Martinez is evidence of Shell's special attention to diesel engine problems as a result of the railroads' increasing reliance on diesel power, it was explained. As the railroads put more and bigger diesels on the job, mechanical growing pains and deficiencies in lubricants, of course, began to be felt.

Already the initial tests at Martinez have contributed to the development of new lubricants that will allow locomotives to remain on the job for years without a major overhaul. According to Shell engineer F. H. Caudel, it consumes a barrel of diesel fuel an hour but uses up only about a quart of lubricating oil in the same time.

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Laboratory Continuous Stills—Apparatus and Operation

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CONTINUOUS distillation has distinct advantages in the laboratory as well as the plant. In the past most lab men have avoided continuous distillation because of the problem of controlling the small flows required.

This article presents methods for control of small flows, and shows how to make continuous distillation a practical tool in the laboratory. Included is a complete discussion of the apparatus and technique of operation for continuous laboratory stills.

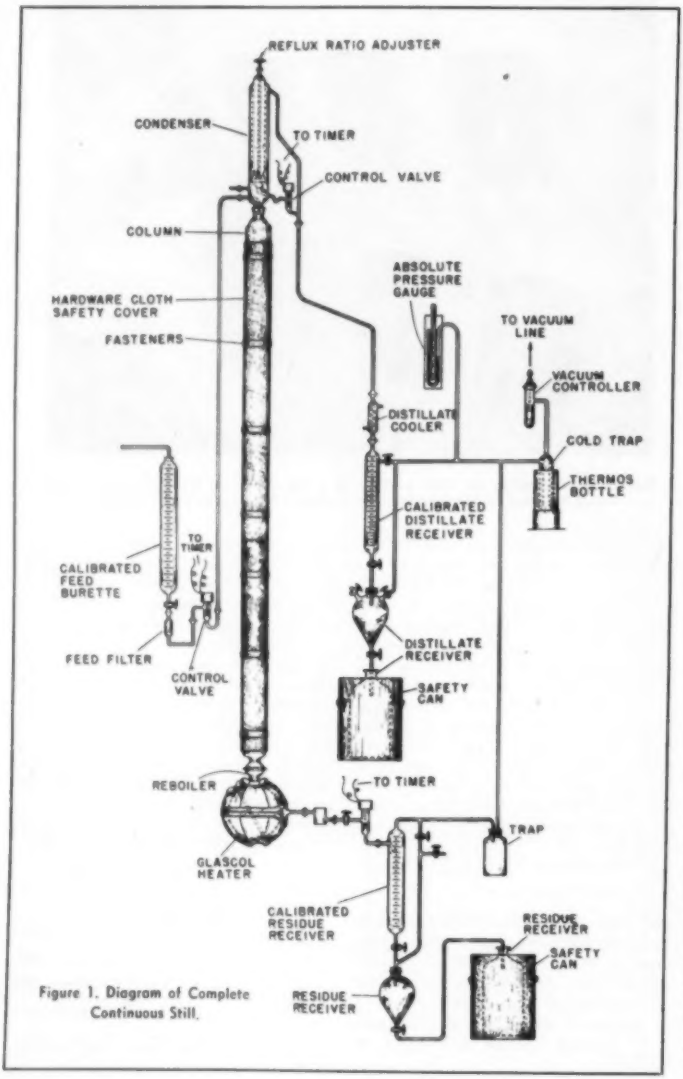

Figure 1. Diagram of Complete Continuous Still.

CONTINUOUS distillation of chemicals and petroleum has many advantages over batchwise distillation.[1] In recognition of these advantages, commercial distillations are made continuous wherever practicable. The theoretical principles as well as the practical operation and equipment requirements are generally well known. Many laboratory distillations are preformed batchwise because the necessary equipment is not readily available for continuous laboratory distillation and because of a general belief that small continuous stills offer many operating difficulties. The only real difficulty is the adequate control of small liquid flows. A solution to this problem will be presented and general instructions given for setting up and operating a laboratory size continuous still.

Equipment

Because of the advantage of visual observation, cost, ease of fabrication and chemical inertness, glass equipment is recommended for most laboratory continuous stills.

1) *Columns*

Packed columns, Figure 1, may be made with length and diameter to give the required number of equivalent theoretical plates and throughput for any particular separation. The packed column has advantages of low cost, ease of fabrication, ease of cleaning and variation of the number of available equivalent plates. Raschig rings, Berl saddles, McMahon, protruded metal, glass and metal helices and many other packings are commercially available, and offer a wide selection in operating characteristics. The packing can be chosen to give maximum number of plates, maximum throughput or intermediate values of each. Remember that the number of equivalent

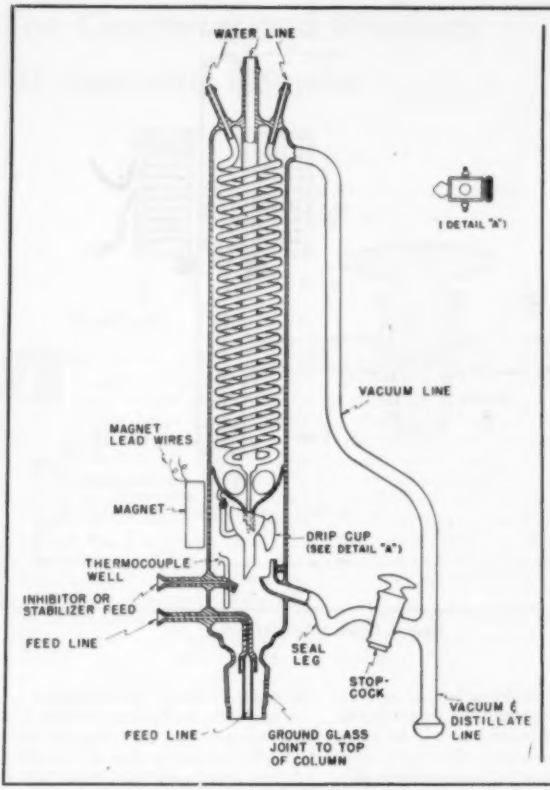

Figure 2. Details of Intermittent Still Head.

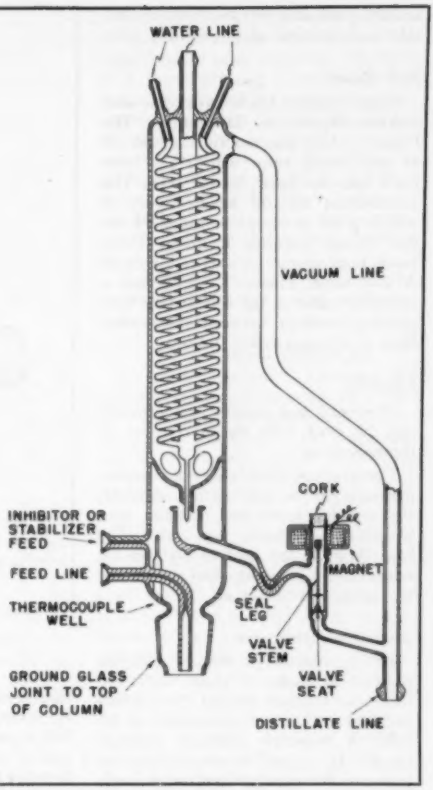

Figure 3. Details of Constant Distillate Head.

plates increases directly as the depth of the packing in a column and the throughput varies as the square of the column diameter.

The column should be kept at or near adiabatic conditions throughout its length. This is partially accomplished by well insulating the outside of the column with a commercial insulation or jacketing the outside of the column with a second glass shell and reducing the annulus to a low pressure. Aluminum foil inserted in the annulus will reduce heat loss due to radiation. More completely adiabatic conditions are had if the insulated column is wrapped in sections with heating coils and automatically held at the same inside and outside temperature throughout the column length. H. J. Hepp and D. E. Smith in an article in Ind. Eng. Chem., An. Ed. *17*, 579-80 (1945) describe in detail one such adiabatic heating system.

The feed point to the column may be positioned by choosing the desired point from a series of openings into the side of the column or in the case of vacuum jacketed columns by extending a feed tube (Figure 1-B) from the top of the column along its axis so that the bottom end of the feed tube is at the desired position in the column. The feed tube is placed in the column as the packing is added. The male and female parts of a small pyrex glass syringe are used as a ground glass joint to connect the tube to the feed inlet in the still head. For most practical distillations the feed should be in the middle third of the column, hence, it is usually sufficient to have one feed inlet in the middle and two others, one-third from each end respectively.

Feed

The feed to the still must be at a constant, controlled rate. This is the problem which has baffled most would-be laboratory continuous still operators. Two methods of controlling low liquid flow rates, which have proved satisfactory for small continuous stills, are the double syringe pump, and a glass solenoid type metering valve. The syringe pump[2] will feed uniformly at rates of 25 to 3000 cc. per hour. The metering valve (C, Figure 1, similar to discharge valve shown in Figure 4), operates on the principle of controlled intermittent flow. The duration of the open and closed part of the cycle can be regulated independently to control the rate and keep the feed cycle small so as not to upset the column. In each method the feed rate is measured by readings on the calibrated feed burette (D).

Reboiler

One, two or three liter flasks heated with a heating mantle (E) are large enough for the required inventory and heat transfer for most distillations on columns three inches or less in diameter. A side take-off (F) is required for residue discharge and a thermometer well for reading of reboiler temperature. A ball-and-socket ground-glass joint allows for flexible, vapor-proof connection of reboiler to column. A metering valve (G) (See detail Figure 4), allows control of the residue rate

and the graduated residue receiver (H) allows measuring of the residue rate.

Still Heads

Three types of heads have been used successfully in our laboratory. The Corad,[3] which has continuous take-off at any reflux ratio which has been built into the head, is one type. The intermittent take-off head, Figure 2, which gives a complete range of reflux ratios, requires a timer. These heads both operate at a set reflux ratio. A still head, Figure 3, which has a metering valve in the forwarding line, gives a constant forward rate rather than a constant reflux ratio.

Controls

Overhead and residue temperatures can be read with thermocouples or thermometers.

For vacuum distillations a constant pressure can be held with a commercial control valve and vacuum controller or a cartesian type valve. The heat input to the heating coil on the reboiler can be controlled by setting the voltage on a variac.

Auxiliary Equipment

All equipment in contact with the product is made of glass. Ball and socket or tapered ground glass joints are used for connecting the units of the still. A mercury absolute pressure gauge (J) is used to read distillation pressures for vacuum distillation work. Vacuum pumps or steam jets may be used as a source of vacuum.

Operation

To make a given distillation, the operator must choose equipment with sufficient separating ability (number of plates) and throughput and auxiliary equipment to give adequate control of all variables. The equipment must be thoroughly cleaned and assembled and all joints and stop cocks greased. The reboiler is charged with an initial charge of the feed stock to fill it slightly more than half full. The heat is turned on, and the column is brought to equilibrium at total reflux. If the feed composition is known, one can calculate what fraction should be taken overhead to give the desired separation, leaving a little leeway for fluctuations in still operation. In this case after equilibrium at total reflux, the feed can be started and overhead taken off until the calculated amount of the initial charge plus the feed up to that time has been taken as distillate, at which time residue can start to be taken. It should be remembered that a packed column should be operated at a vapor rate only slightly less than the flood point for maximum efficiency. This vapor rate and the required reflux ratio fix the distillate rate. The feed and residue rates are the ones which must be changed to give the desired percent as distillate. When the composition of the feed is not known, the feed rate is set equal to distillate rate and the column operated with no residue take-off until distillate begins to show traces of material desired to be kept in the residue, i.e., until the head temperature shows a slight increase. The fraction taken overhead at this point indicates the percent to take as distillate with the given feed composition.

Data which should be taken are feed, distillate and residue rates, reboiler and head temperatures, heat input and operating pressure, plus any other data pertaining to a particular method of control.

The column is shut down by putting the condenser on total reflux and shutting off the reboiler heat, and the feed and residue flows. When cool the reboiler may be removed and emptied and all equipment cleaned and greased.

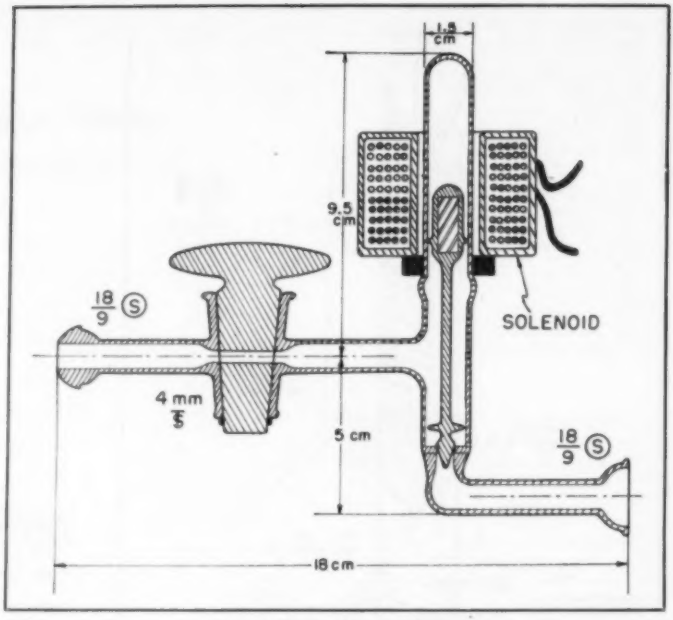

Figure 4. Details of Solenoid Valve.

Summary of Rate Determinations

Vapor rate is fixed by column size, kind of packing, operating pressure and physical properties of the feed. (Adjust heat to reboiler to operate at slightly below flood point.)

$$\text{Distillate rate} = \frac{\text{Vapor rate}}{1 + \text{Reflux ratio}}$$

$$\text{Feed rate} = \frac{\text{Distillate rate}}{\text{Fraction of feed to be taken as distillate}}$$

$$\text{Residue rate} = \text{Feed rate} - \text{Distillate rate.}$$

Safety

Every precaution should be taken to eliminate hazards from equipment. Glass columns should be covered with insulation and/or wrapped with hardware cloth. Glas-col heaters furnish good protection for the reboiler and furnishes heat without a source of ignition. Feed and product bottles can be kept in metal safety cans to reduce possibilities of breaking bottles and spilling inflammable or toxic liquids. Fire fighting equipment, eye and face protection, gas masks and emergency exits should be provided.

* * *

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The Chemistry and Rheology Of Asphaltic Bitumen

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Part I

THE TERM, *bitumen*, in its broadest sense, has been defined by the American Society for Testing Materials as "a mixture of hydrocarbons of natural or pyrogenous origin, or a combination of both, frequently accompanied by their non-metallic derivatives, which may be gaseous, liquid, semi-solid, or solid, and which are completely soluble in carbon disulphide."

In its relation specifically to petroleum, *asphaltic bitumen* is defined as "a black to dark-brown solid or semi-solid cementitious material which gradually liquefies when heated, in which the predominating constituents are bitumens, all of which occur in the solid or semi-solid form in nature or are obtained by refining petroleum, or which are combinations of the bitumens mentioned with each other or with petroleum or derivatives thereof."

It is unfortunate that British technologists invariably refer to asphaltic bitumen simply as "bitumen," whereas in the United States the same substance is always described as "asphalt." In British practice, however, the latter term has been reserved solely for natural or mechanical mixtures in which asphaltic bitumen is associated with inert mineral matter.

Since there has not yet been universal acceptance of any particular term, the writer prefers to make no distinction and generally uses the terms "bitumen," asphaltic bitumen" and "asphalt" synonomously.

Production of Asphaltic Bitumen

Asphaltic bitumens may be divided broadly into two classes:

i) Native asphalts, e.g. Trinidad or Bermudez lake asphalts, and natural rock asphalts or asphaltites such as gilsonite and grahamite.

ii) Pyrogenous bitumens as produced in the refining of petroleum oils.

Native asphalts usually contain varying percentages of mineral matter and water. Before use they often require dehydration by heating to about 300° F. In some cases, the bitumen is separated from the mineral matter by means of a solvent which is later recovered by distillation.

Pyrogenous asphalts are termed "straight-run" or "cracked" according to the method of production. When they are processed by blowing with air they are said to be "air-blown". Since the writer's researches have been carried out mainly on pyrogenous bitumens, it will be convenient to discuss their production briefly.

(a) Straight-Run Bitumens

The bitumen present naturally in asphaltic crude oils is normally recovered by vacuum or steam distillation, or by a combination of such methods, with or without the introduction of inert gases. In these processes, known as "straight-reduction", the volatile fractions are removed under fairly mild temperature conditions, so as to avoid deterioration of the asphaltic residue by overheating during distillations at atmospheric pressure. At low pressures the possibility of polymerization and the formation of free coke is appreciably reduced.

THE GROWING demand for high-grade asphalts required for the construction of highways and airports throughout the world is closely associated with the ever-increasing consumption of other petroleum products arising from the tremendous growth of the automotive and aeronautical industries. This article outlines the methods used in the petroleum industry for the production of straight-run, cracked and air-blown bitumens, followed by a review of the literature on fractional constitution, internal structure and colloidal nature.

Part II, to appear in an early issue, will discuss the effect of chemical composition on the rheology of asphalts.

The process in large scale practice is usually of a continuous nature. The light vapors pass from the top of a flash tower through a series of fractionating columns and are finally condensed, while the bituminous residue is continuously drawn off from the bottom of the unit. The "consistency", or degree of hardness, of the bitumen is controlled by the rate at which it is removed and by the temperature and pressure of the oil feed entering the tower.

Straight-run bitumens are produced primarily for use in road surfacing compositions.

(b) Cracked Bitumens

In straight reduction processes the temperature is seldom allowed to exceed 600°-650° F., otherwise decomposition or cracking of the molecules occurs, the actual degree depending on the pressure and on the time of subjection to the higher temperatures.

In normal refinery cracking processes where the primary object is to produce petrol from gas oil and kerosine stocks, temperatures may vary from 850° F. in liquid phase operation to 1100° F. for vapor phase. Pressures may range from about 200 to 1000 psi. The importance of careful control of cracking conditions has been stressed by the writer in an earlier publication,[58] where the cracking reaction has been shown to proceed about thirteen times as rapidly at 1000° F. as it does at 900° F.

In the cracking process considerable amounts of heavy bituminous residue are produced mainly by dehydrogenation and polymerization of lighter molecules. This pyrogenous residue, if not removed from the system, would ultimately be converted to coke. It is usually separated at a reduced temperature of about 600° F. in a vacuum fractionating tower, and constitutes what is generally known as "cracking coil tar" or bitumen. The bitumen is termed "severely cracked" or "mildly cracked" depending on the temperature, the pressure, the time of cracking and on the chemical composition of the molecules.

In certain instances the degree of cracking may be so severe that the heavy residue can be used only for fuel purposes. On the other hand, the highly cracked material is often blended with the parent straight-run bitumen. The quality of the resultant "partially cracked" product is then dependent on the relative proportions of the cracked and straight-run constituents and on the properties of the natural bitumen itself. The possible number of combinations of straight-run and cracked bitumens is of course unlimited.

It is noteworthy that cracked bitumens, if carefully prepared, may have the same solubility in carbon disulphide as straight reduced asphalts. However, they invariably have higher specific gravities owing to their increased aromaticity. Egloff and Morrell[21] illustrate the chemical changes thus:

The bitumens produced in this way are a complex system of the above substances, the proportions depending upon the actual conditions of the cracking process.

(c) Air-Blown Bitumens

Many oils and bituminous residues are highly susceptible to oxidation. Air blowing of such materials at temperatures ranging from 400° to 600° F. usually makes the bitumen more rubber-like and often brings about an improvement in the general characteristics, but not necessarily always.

In this method, the more volatile fractions are carried off from the asphaltic residue by entrainment. The oxidation is mainly a dehydrogenation process, as evidenced by the large amount of water which invariably results. The constituents of the bitumen consequently become unsaturated in nature and are polymerized by the further action of air and heat into more complex bodies. It also follows that this procedure leads to an increase in the carbon to hydrogen ratio.

In practice, air blowing of the bituminous residue usually follows vacuum distillation, particularly where it is desired to produce a bitumen with a high softening point. As indicated earlier, this result cannot be achieved in a vacuum unit where the limiting consistency of the bitumen is governed by the amount of material which must be drawn off in a given time to keep the refining process continuous.

In cases where the oils are particularly sensitive to heat and are liable to damage at high temperatures, it is often advisable to reduce the materials down to the desired grade of bitumen consistency by direct air blowing at low temperatures, without first obtaining very soft residues by vacuum distillation.

The oxidation reaction is highly exothermic, so that air-blowing is often started at a lower temperature than is finally desired. Usually no additional external heating is required, particularly if the stills are initially charged with hot materials from other units. The disadvantage of this method, from the point of view of production, is that the oxidizing period may vary from anything up to 15 or even 20 hours depending on the size and nature of the charge, the temperature of blowing and the specification of the ultimate product. In such cases batch processes are of necessity adopted.

On the other hand, by judicious manufacture, it is often possible to modify the conditions of operation and to produce bitumens of widely varying characteristics so as to meet special requirements unobtainable in any other way.

Fractional Constitution

Marcusson[46] has divided the benzene-soluble portion of bitumens into four fractions: 1) Asphaltenes; 2) Oily constituents; 3) Asphaltic resins; and 4) Asphaltic acids and their anhydrides.

The portion insoluble in benzene may be subdivided into two further groups: 5) Carbenes—the component soluble in carbon disulphide but flocculated in the presence of carbon tetrachloride; and 6) Carboids—the component insoluble in carbon disulphide. This fraction also includes any mineral matter which may be present.

The procedure generally adopted for the separation of bitumen into the above fractions has been fully described by Broome.[10]

Brief descriptions of the properties of these constituents are given below. It should be pointed out at the outset that the physical, chemical and structural characteristics of the various groups vary with the origin and method of manufacture of the asphaltic materials.

The various theories of the probable molecular structures of each class have been well summarized by Murphy.[51] All evidence points to unsaturated cyclic structures, which are in part aromatic.

A new method for the separation of asphalt constituents has recently been developed by O'Donnell.[59] This involves a preliminary separation by distillation into fractions of fairly narrow molecular size, followed by removal of sulfur and nitrogen compounds with mercuric chloride. The various fractions are then subjected to silica gel chromatography for separation of the saturates, aromatics and resins. The waxes present in the saturated hydrocarbons are further separated by solvent dewaxing and the paraffins removed therefrom as complexes by reaction with urea. Naphthenes are segregated in the liquid state by thermal diffusion whilst the aromatic fractions obtained from the silica gel chromatograms are rechromatographed over alumina gel into monocyclic and dicyclic aromatics.

1) *Asphaltenes*:

Asphaltenes are usually hard, brown to black brittle particles, soluble in chloroform and carbon disulphide, sparingly soluble in diethyl ether and acetone and almost insoluble in alcohol and petroleum ether.

On the application of heat they first undergo a slight shrinkage, then swell, and finally fuse with decomposition to a viscous tarry mass of brilliant black color.

They are probably formed by condensation and dehydrogenation from naphthenic hydrocarbons of lower molecular weight. In character they are predominantly aromatic. Ultimate analyses by Thurston and Knowles[85] of asphaltenes from six different bitumens show that they are composed of from 80 to 90 percent carbon, 6 to 10 percent hydrogen, 0.6 to 8 percent sulfur and a small proportion of oxygen and ash, with possibly nitrogen and traces of chlorine present.

Whilst there is general agreement as to the order of magnitude of the mean molecular weight of the oil and resin-type fractions, widely divergent values have been reported in regard to the asphaltenes.

Determinations by Pfeiffer and Saal[66] have indicated that the molecular weight of the asphaltene constituents of bitumens may vary from 80,000 to 140,000, but the work of Hillman and Barnett using cryoscopic methods[26] gives values of 2400 with benzene and 1660 with naphthalene. Similarly Zapata[99] reports a mean molecular weight of 2000. In this connection, Mack[43] has demonstrated by a dilute solution viscosity method that association of the asphaltenes in asphaltic bitumens exists at low temperatures, but that dissociation occurs at elevated temperatures. Thus, the molecular weight of asphaltenes is shown to be 1800 at 248° F, while the values are approximately 3000 and 5000 at 100° F. and 32° F. respectively.

Eckert and Weetman[20] have shown that the cryoscopic method for the determination of molecular weights of organic substances is not applicable to asphaltenes, though it is quite satisfactory for oils and resins. Using benzene as solvent, they adopted a comparative viscosity method for dilute solutions similar to that previously used by Mack and reported still lower molecular weights for the asphaltenes ranging from 700 to 1000. The individual results however varied with the source of the bitumens and with the degree of processing to which they had been subjected.

The asphaltenes are responsible for the hardness, color and body of the bitumen. By themselves they do not have sufficient cementing properties, and are generally regarded as the organic "filler" of the asphalt.

According to Suida,[82] natural asphalt contains as a rule over 30 percent asphaltenes, good petroleum asphalts nearly 20 percent, poor asphalts over 10 percent, and transition products from petroleum asphalts to pitch percentages ranging from zero to 10.

Such findings do not however always apply and are not in general confirmed by the present writer's experimental work, which points conclusively to vast differences in the natures of the various constituents of bitumens from a number of sources and having similar contents of asphaltenes.

In this connection, observations by Bestougeff and Darmois[9] are significant. Asphaltenes precipitated by petroleum ether from the bitumens produced from a Middle East and a Venezuelan crude oil were successively extracted with petrol fractions of increasing boiling range followed by blends of petrol with benzene. At comparable molecular weights, the Middle East fractions were distinctly less fusible than those from the Venezuelan bitumens. The elementary composition of the various Middle East fractions did not differ to any appreciable extent. The initial fractions were partly distillable (40 to 50 percent) without decomposition up to about 480° F. under a very low vacuum. The investigators conclude that asphaltenes are part of the heterocyclic constituents of petroleum which follow heavy hydrocarbons in a sequence of increasing molecular weights.

An entirely different approach to the problem has been made by Williford[94] who studied X-ray diffraction patterns on different types of bitumens with a view to distinguishing between materials meeting identical conventional specifications, including among other properties such characteristics as content of asphaltenes, resins and oil. A comparison of intensity curves showed important distinctions in the small-angle scattering, indicating essential differences in the amount and nature of the discrete particles present in the various bitumens of apparently identical fractional constitution.

2) *Oily Constituents.*

The oily constituents of asphalts are soluble in practically all organic solvents. They are optically active and are usually fluorescent. When recovered from pyrogenous asphalts, they have the appearance of a clear, viscous, reddish-brown vaseline, but when obtained from natural asphalts they are fluid and sticky at ordinary temperatures, due to the smaller percentage of waxy solid paraffins which they contain. This group can also be separated into saturated and unsaturated compounds.

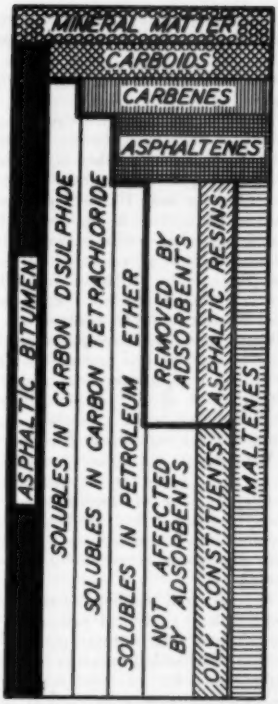

Figure 1. Fractional Constitution of Asphaltic Bitumen as Determined by Selective Solvent Analysis.

Zapata[99] gives their molecular weight as 500. Eckert & Weetman[20] report values ranging from 370 to 710.

The hydrogen content in relation to the carbon is higher than that of the other constituents of asphalt.

On heating, oxidation or sulphurization, the oily constituents are converted into asphaltic resins.

In general, the binding, flow and weathering properties of a bitumen are largely dependent on whether the oily constituents are predominantly aromatic or aliphatic in character. If they are easily evaporated or oxidized, they may shorten the useful life of the material by rendering it brittle.

3) *Asphaltic Resins.*

Asphaltic resins are reddish to dark brown solids having a fusing point of about 200° F. They are soluble in most of the common organic solvents but only sparingly in acetone. Clay, fuller's earth, activated alumina and silica-gel have polymerizing actions, so that when asphaltic resins are adsorbed by any of these materials they become insoluble in petroleum ether.

The carbon-hydrogen ratio, oxygen, sulfur and molecular weights are generally intermediate between those of the oily constituents from which they have been formed and the asphaltenes into which they are condensed.

Zapata[99] gives the molecular weight of resins as about 1000. Values from 540 to 900 are reported by Eckert and Weetman.[20]

The resinous constituents impart adhesiveness and plasticity to the asphalt. Deficiency of these constituents means inferior stickiness; as a result, the asphalt tends to be short and "cheesy".

The oily constituents and asphaltic resins together make up the "soft-asphalt" fraction. They are often referred to collectively as the "maltenes" or "petrolenes". These terms designate that portion of the asphalt which is completely soluble in petroleum ether as contrasted to the hard asphalt fraction, i. e. the asphaltene portion, which is precipitated.

4) *Asphaltic Acids and Anhydrides.*

Asphaltic acids are also known as asphaltous[51] and asphaltogenic acids.[10] They are dark brown, tarlike masses soluble in chloroform and alcohol. On heating they are transformed to unsaponifiable substances similar in appearance to asphaltenes. This probably explains their low concentration in pyrogenous asphalts as compared with the natural material.

Asphaltic acids are considered to be closely related to asphaltenes, being derived from petroleum hydrocarbons by a complex type of oxidation—sulphurization—condensation reaction. They become acidic in nature by virtue of the production of carboxylic groups.

Asphaltic acid anhydrides are undoubtedly formed by dehydration of the parent asphaltic acids.

5) *Carbenes.*

Carbenes are usually present only to a very small extent (a fraction of 1 percent) in straight-run asphalts. Their presence in larger quantities is usually indicative of severe cracking or overheating of the bitumen during processing. They appear as a brown to black powder, when the carbon disulfide in which they are dissolved is evaporated. Carbenes are flocculated in the presence of carbon tetrachloride. They appear to be highly polymerized products of the asphaltenes, have a high oxygen and sulfur content and extremely high molecular weight exceeding that of the parent asphaltenes.[85]

While not of a damaging character themselves, carbenes are an indication of damage which has been done

to the other constituents of the bitumen.[72, 37]

6) *Carboids.*

Strictly speaking, carboids should not be included in the study of asphaltic bitumen, since they are insoluble in carbon disulphide, but their importance as an index of cracking intensity is unquestionable, particularly in high level cracking processes.

According to Hillman & Barnett,[27] carboids can be brought into sensible solution by the prolonged action of such a powerful solvent as pyridine, whereas petroleum coke is only very slightly soluble in this solvent. This fact shows that carboids are not identical with petroleum coke but still contain a certain proportion of hydrocarbon chains or rings which may be firmly bound to a carbon nucleus.

Carboids are generally regarded as being the final stage of the metamorphosis of asphaltenes.

Review of Literature on Fractional Constitution

The fractional separation of asphaltic bitumen constituents by selective solvent action as indicated above has been illustrated diagrammatically in Figure 1. Much criticism has been levelled at the foregoing classification, which is based on the differential behavior of solvents and treatment with fuller's earth, or other adsorbent, particularly as temperatures of solution and conditions of adsorption have not been standardized. The experimental results reported in different laboratories are consequently not strictly reproducible. Furthermore it is not always possible to obtain an absolutely identical supply of petroleum ether which is required for the determination of asphaltenes. For this reason, Lang and Thomas[39] have found it necessary to allow a deviation between duplicate results of as much as 3 percent. Many investigators feel that better results can be had by substituting as solvent definite chemical compounds having uniform and unchanging properties.

Nellensteyn and Kuipers[56] have found that petroleum ether gives a higher asphaltene precipitate than diethyl ether, although both solvents have the same surface tension. They have demonstrated that this phenomenon is due to incomplete miscibility of the oily medium and the protective bodies of the colloidal bitumen system. In their opinion, diethyl ether is therefore preferable to petroleum ether for the asphaltene determination. This view is supported on theoretical grounds, because the asphaltenes recovered with diethyl ether are in most instances pure flocculates, while the petroleum ether precipitates of asphaltic bitumen are mixtures of a flocculate with a demixing precipitate.

Lewis and Welborn[42] quote one American State specification in which solubility in diethyl ether is required instead of petroleum ether. Zapata[99] and Hoiberg and Garris[28] propose the use of hexane in the belief that petroleum ether tends to precipitate small fractions of resins along with the asphaltenes. Hillman and Barnett[27] prefer isopentane. Batchelder and Wellman[4] favor heptane as an effective asphaltene precipitane, whilst Strieter[81] shows that normal pentane precipitates asphaltenes consistently within limits of 0.3 percent. He also prefers diethyl ether to carbon disulphide for the extraction of resins.

Winterkorn and Eckert[95] utilize a series of solvents for the progressive precipitation of asphaltenes, viz. methyl acetate, ethyl acetate, propyl acetate, butyl acetate, amyl acetate, and petroleum ether, in the order named.

Hubbard and Stanfield[31] have standardized their analytical procedure for asphaltenes with normal pentane as solvent. The soluble portion is further fractionated by adsorption of the resins on activated anhydrous alumina instead of fuller's earth, followed by a two-stage solvent extraction, firstly with pentane to obtain the oily constituents and then with a methanol-benzene solution to yield the resin fraction. Other workers advocate the use of silica gel as an adsorption agent for asphaltic resins.

It is an established fact that oxidation is a major interfering factor during the adsorption of resins by fuller's earth and again in the subsequent extraction and drying operations. In order to overcome this difficulty, Suida and Motz[83] propose that all such work be carried out in an atmosphere of nitrogen, with chloroform as the solvent during the adsorption process, and with pyridine during the final extraction. They also advocate keeping the temperature of adsorption and extraction low and within very narrow limits, and to separate asphalts into a petroleum portion, asphaltic resin, petroleum resin and hard asphalt. The resulting hard asphalt contents obtained by their procedure are shown to be far lower than those stated in analysis of the asphalts with other methods.

It is clear from the foregoing that *the fractions separated in solvent and adsorption analysis do not represent definite hydrocarbons but are rather arbitrary classes of material defined by the method of separation and by the surface tension and miscibility properties of the solvents used.*

Thus, according to Nellensteyn,[56] the critical surface tension for bitumen is 26 dynes per cm. at 25° C. With solvents which have a surface tension between 24 and 26 dynes per cm., the occurrence of flocculation or peptization depends on the degree of stability of the micelles dispersed in the oily medium. Therefore, solvents such as pentane, diethyl ether, n-hexane, and n-heptane which have surface tensions ranging from 13.5 to 18.6 respectively have a flocculating effect on the micelles dispersed in the oily medium. Chloroform 26.2, benzene 27.7, toluene 28.4, xylene 29.1, carbon disulphide 30.6, pyridine 34.9 and nitrobenzene 42.5 have a strong peptizing effect, while carbon tetrachloride 25.4 and cyclohexane 25.7 have an intermediate action.

Nellensteyn points out that asphaltenes can be brought into total solution by a mixture of equal parts of diethyl ether (surface tension 16.7 dynes per cm.) and aniline (42 dynes per cm.), although they are actually precipitated by the individual solvents themselves. In the case of ether alone, the lack of solubility is due to the low surface tension of the solvent, whilst aniline is totally immiscible with the protective bodies associated with the asphaltenes. This illustrates the dependency of the solubility properties on both surface tension and miscibility characteristics of the solvent.

It is worth noting Nellensteyn's striking observation that the relation between the peptizing qualities in bitumen analysis and the aromatic character of certain solvents is purely accidental. Thus, in the list of liquids just quoted, there are several non-aromatic compounds which also possess a peptizing property with asphaltic bitumen; on the other hand, benzene, toluene and other aromatic compounds are actually flocculents for coal tar, which is an allied colloidal system of highly aromatic character.

Despite the empirical nature of the separations, solvent analysis if standardized can be of considerable importance in interpreting various phenomena and the present investigator has utilized such methods in his experimental researches. These are discussed more appropriately in other publications[101, 102] dealing with the durability characteristics of different classes of asphaltic bitumens.

Theory of Formation of Native Asphalts

The foregoing discussion gives a clue as to the formation of asphalt occurring in the native state. It is gen-

erally recognized that temperature, pressure and time have all had a hand in deciding the character of natural asphaltic bodies in crude petroleum. The nature has also probably been affected by chemical reaction with oxygen from the atmosphere and with sulfur and oxygen in adjacent rock deposits.

Other fundamental chemical processes such as polymerization, depolymerization and distillation have undoubtedly also played a major part in nature, just as they each have their own characteristic effects in refining practice. Polymerization in particular is considered to be responsible for the production of asphaltenes from oily constituents and resins by condensation of parts of their molecules. The asphaltenes in turn polymerize to carbenes, which are still more complex in their molecular structure, and these in turn are condensed to carboids. With the continued conversion of oily constituents and resins into asphaltenes and carbenes, the asphaltic material becomes harder and harder, so that natural asphalts are probably the final residues formed from liquid oils.

This explains why some deposits, like the Alberta tar sands, are still fairly soft with softening points ranging from 40° to 90° F., the asphaltene content being approximately 12 percent. Trinidad asphalt contains about 37 percent asphaltenes and softens at about 140° F., whilst gilsonite with 80 percent asphaltenes has softening points ranging up to 400° F. At the other extreme, grahamite which may contain as much as 80 percent carbenes does not soften below 600° F. It has been shown that even grahamite can ultimately be further metamorphosed to become "impsonite" which contains only infusible carboids. This final condensation product, being totally insoluble in carbon disulphide, cannot however, by definition, be correctly classed as a bitumen.

Colloidal Nature of Bitumens

The theoretical aspects of the constitution of asphaltic bitumen have been treated by many investigators[42, 43, 67, 80, 86, 95, 1, 65, 66, 90, 92, 3, 84, 50, 64, 102] and there is general agreement that these materials are colloidal systems consisting of micelles dispersed in an oily medium. This conception has now led to the abandonment of the classical theory of Marcusson,[46] which regards bitumen as a mixture of various organic compounds with no differentiated structural functions.

That bitumen is a colloidal system has been well demonstrated by Katz and Beu[84] who examined thin films of bitumen under the electron miscroscope in a search for colloidal asphaltene particles. Photomicrographs at a magnification of 156,000 did not indicate the presence of such colloidal particles though they were immediately evident when examinations were made of suspensions of petroleum ether from which asphaltenes were precipitated. The investigators concluded that if asphaltene particles are at all present in undiluted bitumen, the particle size is less than 65° A in diameter.

From the standpoint of colloids, asphaltic bitumens may represent mixed systems containing varying proportions of sols in conjunction with any of the numerous possible gel-like structures, depending upon the prevailing conditions of temperature and pressure, their chemical and physical composition, and their previous history. This is in accordance with the views of Pfeiffer and van Doormaal,[67] of Saal and Labout,[76] and of Traxler and his associates.[91]

Since asphaltenes do not melt and maltenes behave as a viscous oil, it is natural to consider the high molecular asphaltenes as being the dispersed medium in the colloidal bitumen system, with the low molecular maltenes as the dispersing medium.

Mack's[42] conception of the structure of bitumen is that the asphaltenes and carbenes are distinct entities dispersed in a medium consisting of a solution of asphaltic resins in the oily constituents. A part of the resins is adsorbed by the asphaltenes and carbenes by secondary valence forces, where they possibly function as a protective colloid but are dissolved when the asphaltenes are precipitated in petroleum ether, or when the carbenes are flocculated by carbon tetrachloride.

According to Nellensteyn's theory[52, 53] asphaltic bitumen is a highly protected lyophobe sol, in which each asphaltene micelle has a nucleus of carbon—so small as to be detected only by the ultramicroscope—surrounded by an atmosphere or shell of successive layers of hydrocarbons of lower molecular weight and higher ratio of hydrogen to carbon, which are held to the surface of the solid particle by adsorptive forces. These lyophobic asphaltene micelles are considered to be maintained in dispersion in the continuous oily medium by the lyophilic asphaltic resins which serve as protective colloids or stabilizing agents.

The only part of this theory which has not received general acceptance, according to a) Pfeiffer and Van Doormaal[67] and b) Traxler and his co-workers,[90] is the concept of a carbon kernel for each micelle. In this respect, it is of interest to note that Nellensteyn's original conception was that the nucleus might consist of a minute solid hydrocarbon or even mineral particle, but in his later work,[54] he demonstrated by X-ray diagrams that graphitic carbon is present in asphaltenes. Additional confirmation was also obtained in his studies of the oxidation products of asphaltenes.

McLeod,[48] however, supports Mack's viewpoint as being the more rational, on the ground that Nellensteyn's asphaltene fraction must consist of Marcusson's asphaltene fraction plus part or all of Marcusson's asphaltic resins, and this combination is scarcely in accord with the physical and chemical properties of the two materials. In addition, in the determination of asphaltenes, the resistance of the adsorbed resins to leaching with petroleum ether, in which the resins are soluble, is not in agreement with the generally understood behavior of adsorbed materials.

McLeod also cannot accept Nellensteyn's further suggestion that the adsorbed resins are dissociated and adsorbed as ions, which would explain their ability to withstand leaching with petroleum ether, since this would mean that the adsorbed resins are present as free radicals. This view does not seem reasonable since free radicals are very reactive chemically, and asphalts are relatively inert materials.

For purposes of comparison, it is of interest to note here that Dickinson[19] recently produced evidence that coal tar, examined by the electron microscope, shows a particle structure of colloid dimensions, and can be classed as an "associated colloid", in which the units are composed of a core of hydrocarbons of high molecular weight, surrounded by a solvation layer of hydrocarbon molecules of lower molecular weight. These micelle units are dispersed in a continuous oily medium and there is no abrupt discontinuity of phase between this medium and the nuclei of the micelles.

Effect of Colloidal Nature on the Rheology of Asphaltic Bitumens

The tendency for asphaltic bitumens to display anomalous flow characteristics such as plasticity, thixotrophy and elasticity confirms the conclusions arrived at by other methods of investigation in regard to the colloidal character of bitumens.

In general, there is no doubt that the existence and magnitude of abnormal flow properties depend not only on the type of bitumen and on its method and degree of processing, but also on the physical conditions of temperature, extent of mechanical working etc., to which the bitumen has been subjected. Thus under different

circumstances the same materials may be truly viscous or display complex flow characteristics. The whole matter hinges on the ability of the bitumen to change its colloidal character by degrees from a gel to a sol by passing through a mixed gel-sol phase, and vice versa depending on the prevailing conditions. In physical determinations of the rheological properties of bitumens, the method of application of the stress and the rate of shear have a profound influence on the internal structure of the colloidal system at the time of measurement and probably involve changes in the form of distribution of the dispersed phase in the dispersing medium.

Fundamental equations of flow for bitumens of the sol type have been derived by Frohlich and Sack[24] and the theory has been extended further by Sack to cover more complicated structures.[77]

Internal Structure in Bitumens

Traxler and Coombs,[87, 88] in the course of their studies on the flow characteristics of bitumens, showed that those materials which exhibited distinct anomalous flow characteristics displayed the remarkable property of giving surface designs when treated with partial solvents, whereas no effects were obtained with essentially viscous materials. The investigators concluded that such surface patterns are indicative of the presence of internal structure in asphalt, the rate of development increasing with time. This structure is however unstable to heat, to mechanical working, and to the action of solvents.

Traxler and his associates[90, 74] consider that the thixotropic and elastic properties of asphalts are the results of some type of structure caused by selective orientation of certain components of the asphalt. The rate at which this structure builds up has been used for comparing the age-hardening properties of different types of bitumen, and an asphalt aging index has been proposed,[89] based on the rate of increase in the viscosity of asphalts undisturbed for exactly 100 hours. It is shown that agehardening is more pronounced in complex materials such as air-blown bitumens.

Broome[11] is of the opinion that work-hardening, particularly characteristic of highly elastic materials, may be due to the molecular arrangement becoming more regular under the strain. This greater regularity is thermodynamically less probable, and the material therefore develops a stress in an attempt to revert to a less orderly state which is thermodynamically more probable.

Further evidence of internal structure in asphalt has been provided by Holmes and Raphael[29] who have demonstrated, by differences in consistency—temperature relationships, that synthetic asphalts made by blending asphaltenes, asphaltic resins and oily constituents do not combine together in exactly the same manner as they exist in the original bitumen.

End of Part I. Part II will appear in an early issue.

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The MONTH... in the INDUSTRY

PAD Defines 18-Month Oil Expansion Program

The Petroleum Administration for Defense has issued a new 18-month program for necessary expansion on a domestic and foreign basis, including estimates on materials which would be required in the fulfillment of program terms.

Refinery capacity would be increased domestically at an annual rate of 475,000 barrels a day beginning July 1. Foreign expansion would result in an annual increase rate of 384,000 barrels daily during the period. PAD reports the foreign figures do not represent estimates of foreign capacity, but expansion which industry would undertake if materials were made available. Bruce Brown, PAD deputy, said he did not know where the materials could be obtained but reported his point was that the program was based on oil requirements rather than availability of materials.

During the second half of 1952, worldwide refining expansion should reach 890,000 barrels a day according to estimates, but the increase for 1953 is slated to be less than 850,000 barrels daily.

The program would provide for 713,000 barrels daily increase in basic refining capacity over the 18-month period, and calls for a natural gasoline plant capacity increase of 131,000 barrels a day. The entire domestic refining program, including 24 million barrels of tankage, will cost almost $1.3 billion, including increases in aviation alkylate, benzene and sulfur production.

Esmay Replaces Miller As API Information Head

Edwin W. Esmay has been appointed acting director of the API Department of Information and acting executive director of the Oil Industry Information Committee, replacing Rear Admiral H. B. Miller (U. S. N. retired) who has been given leave of absence to serve as president of the National Committee for a Free Europe, a private citizen's organization to fight communism.

Esmay is industrial liaison representative, Public Relations Department, Standard Oil Company (New Jersey).

API Committee Chairmen Assigned for 1952 Season

L. S. Wescoat, president of The Pure Oil Company and chairman of the board for The American Petroleum Institute, has appointed the following committee chairmen to serve in 1952: National Oil Policy, A. Jacobsen, Amerada Petroleum Corporation; Agricultural Advisory, Sidney A. Swensrud, Gulf Oil Corporation; President's Advisory on International Affairs, B. Brewster Jennings, Socony-Vacuum Oil Company; Automotive Safety Foundation Conference Committee, L. S. Wescoat; President's Advisory on Interdivisional Standardization, John R. Suman, Standard Oil Company (New Jersey); Library, B. I. Graves, Tide Water Associated Oil Company; Nomination, R. G. Follis, Standard Oil Company of California; Program and Budget Review, Robert H. Colley, The Atlantic Refining Company; Research, Robert E. Wilson, Standard Oil Company (Indiana); Safety, John R. Suman, Standard Oil Company (New Jersey).

H. S. M. Burns, Shell Oil Company, was appointed head of the public relations committee, the board group to which the Oil Industry Information Committee reports. He succeeds John M. Lovejoy, Seaboard Oil Company of Delaware, chairman 1947-1951.

Hallanan to Direct NPC Sixth Consecutive Term

Chosen to serve his sixth consecutive term as chairman of the National Petroleum Council, Walter S. Hallanan, Plymouth Oil Company president, summarized work achieved by the council as 97 reports completed for the Department of the Interior and six in the process at present time.

Hallanan remarked that the industry had entered this cooperative undertaking with the government with definite guarantees for traditional freedoms, and he noted that through Interior Secretary Oscar Chapman, the government had carried out its part of the agreement. In return, he said, the Council had rendered government a service that could not have been purchased at any price.

Named Sciences Fellow

Dr. Donald B. Keyes has been elected a Fellow of the New York Academy of Sciences in recognition of his outstanding scientific achievements. Dr. Keyes is an adviser of the National Association of Manufacturers Research Committee, a special consultant to Heyden Chemical Corporation and a director of Heyden.

Oil Show Set

The executive committee of the International Petroleum Exposition has recommended that the next oil show be held May 14-23, 1953, in Tulsa, according to W. G. Skelly, president.

W. B. Way, general manager, Tulsa, will provide space reservations or information.

The last such oil show was held in Tulsa in 1948.

ACCIDENT PREVENTION AWARDS were presented to supervisors of the Engineering-Construction Department of General Petroleum Corporation by the American Petroleum Institute after 600 employes at the Torrance, Calif., and Vernon refineries piled up the 1,229,521 accident-free man hours for a departmental award. The Torrance division received a separate award for its 1,041,211-hour record. The men are (left to right): F. P. Lennon, Vernon superintendent; S. M. Lyon, T. J. Sullivan, L. H. Fosburg, John Tipps, A. H. Sievi, J. T. Rothenberger, Elmer Hayes, and B. C. McCoy, Torrance superintendent.

Radioactive TEL Discovery Permits Chemical Study

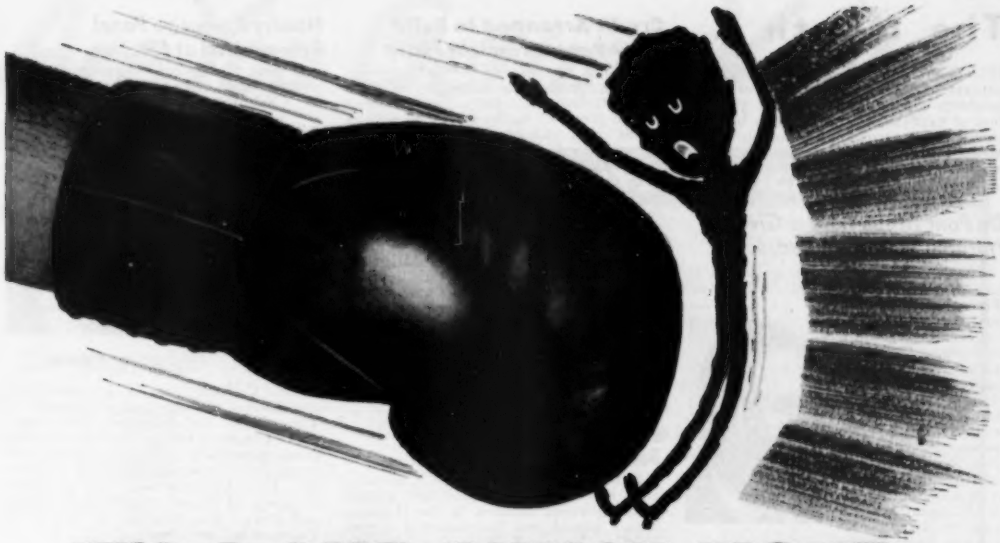
Scientists at Battelle Institute, Columbus, Ohio, have produced what is believed to be the first radioactive form of tetraethyl lead, and foresee, as a result, better anti-knock chemicals through appraisal of chemical reactions. Molecules of tetraethyl lead are composed of atoms of lead, hydrogen, and carbon. The Battelle scientists have substituted an atom of radioactive carbon-14 for one of the eight carbon atoms in the tetraethyl lead molecule.

The radioactive carbon-14 in the "ethyl" will permit the fate of the carbon atoms of the "ethyl" to be followed during the oxidation or combustion of the gasoline. Such studies indicate the chemical importance of anti-knock agents and in turn aid the development of even better anti-knock chemicals.

Battelle scientists expect soon to prepare radioactive forms of petroleum products, such as propane, butane, and hexane. These radioactive compounds will be used in delving further into the chemistry of fuel oxidation and combustion. They believe that research into the chemical details of the reactions occurring during the combustion of fuels can lay the groundwork required for the development of more efficient internal combustion engines.

OPS Stimulates Benzol, Naphthalene Production

Ceiling price adjustments to allow more efficient recovery at coke oven gas streams has been granted producers of benzol and naphthalene as a stimulant to achieve a 10 percent increase during



IT'S A ONE-PUNCH FIGHT...

. . . when a Lagonda 1100 Series tube cleaner tackles the toughest coke that ever fouled a still tube. The Lagonda cutter head wades into the battle slugging at every step, backed up by the irresistible wallop-power of the precision-built 1100 Series motor, with its ball thrust bearings at each end plus its positive lubrication system—features that combine to let the power flow right through to the cutter head, where it will do the most good.

The whole thing is a combination—a super-powerful motor, armed with a super-tough cutter-head that has all the necessary stamina to take the motor's power and turn it into smashed coke. With a combination like this you cut down-time to the bone. Try it. A Lagonda field engineer will help, if you like.

BULLETIN Y-29 gives some pretty convincing facts how to make any coke "say uncle". Mailed on request.

ELLIOTT COMPANY
LAGONDA DIVISION, SPRINGFIELD, OHIO
Plants at: JEANNETTE, PA. • RIDGWAY, PA.
AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

Y-306

The Month . . .

1952. The Office of Price Stabilization expects a 15 percent shortage of these products during 1952. Greater production of naphthalene, particularly by converting idle petroleum distillation equipment to naphthalene production, is expected.

Du Pont Group Leader Given Horning Memorial Award

The Society of Automotive Engineers has awarded Daniel L. Pastell, Du Pont Petroleum Laboratory, the 1950 Horning Memorial Award, given annually to the author of the best paper on the adaptation of fuels to internal combustion engines. Pastell's paper, "Precombustion Reactions In A Motored Engine," was presented at the SAE summer meeting, held at the French Lick Spring Hotel, French Lick, Indiana, June 4-9, 1950.

Pastell

A graduate of the University of Washington, Pastell joined the staff of the Du Pont Petroleum Laboratory, Organic Chemicals Department, in 1947.

Mines Bureau Announces Two Top Level Appointments

Two appointments in the Bureau of Mines named a new chief of the Minerals Division in the Washington headquarters, and a new director of the Bureau's Region V, with headquarters in Minneapolis, Minn.

Paul Zinner, regional director of Region V at Minneapolis, was named chief of the Minerals Division in Washington, succeeding Lowell B. Moon, who has resigned to accept a position in private industry.

Paul T. Allsman, now with the Denver office of the Bureau, was named to fill the regional directorship at Minneapolis vacated by Mr. Zinner.

The Minerals Division, is one of the three major operational divisions of the Bureau. It deals with all phases of the metal and mineral mining industries, planning and coordinating the Bureau's research programs for the conservation and development of the nation's mineral resources.

Dr. Barnard Is Elected 1952 President for SAE

Dr. Daniel P. Barnard IV, research coordinator of Standard Oil Company (Indiana), elected president of the Society of Automotive Engineers for 1952 at the annual business meeting held last month in Detroit, succeeds Dale Roeder of Ford Motor Company. Dr. Barnard received the SAE Horning Memorial Award in 1949 for distinguished active service in matching fuels and engines. He is a chemical engineering graduate of the University of Delaware, Massachusetts Institute of Technology, and did research work at MIT. Dr. Barnard lives at Dune Acres, Ind.

Credit Arranged to Build New Petrochemical Plant

Phillips Chemical Company, wholly owned petrochemical subsidiary of Phillips Petroleum Company, has arranged with a group of banks for a $50 million credit on a standby basis, proceeds to be used to finance important chemical projects. These are a part of the company's long-range program of up-grading products and diversifying markets to improve values received from its raw material resources, officials said.

Part of the funds will be used to build the ammonia methanol and petrochemical plant near Houston, originally projected by Alamo Chemical Company on which construction was recently started by Phillips Chemical Company. In addition, sulfur, carbon black, pyridines, and other chemical and special products will be made at plants included in this expansion program.

Eastern States Announces Benzene Plant at Houston

Eastern States Petroleum Company, Inc., will erect a benzene plant adjoining its present facilities on the Houston Ship Channel and has awarded a contract to Brown & Root, Inc., for the construction. At present the project is in the engineering stage with construction planned as soon as possible.

So-Vac Promotes Nelson To Lab Associate Director

T. W. Nelson has been appointed associate director of Socony-Vacuum Oil Company, Inc., laboratories and will be succeeded as director of the field research laboratories at Magnolia Petroleum Company, Socony-Vaccum affiliate, at Dallas, by Dr. Dayton H. Clewell, who has been assistant director there.

Nelson was graduated from the Colorado School of Mines in 1934 and immediately joined the technical department of the Socony-Vacuum refinery in Augusta, Kansas. He later went to the company's research and development laboratories in Paulsboro and then became director of the Dallas laboratories, a post he has held for the past six years.

Burrill Forecasts Refining Expansion Not Sufficient

The present oil industry structure is not sufficient to either build up to its former reserve refining capacity or to keep pace with normal demand increases, according to Cecil L. Burrill, director of the Petroleum Administration for Defense's Program Division. Burrill said that any additional demands on the industry would cripple the national reserve program. Predicting that over-all shortages of petroleum products would not be felt this year, he judged that expansion during 1952 would not be sufficient to meet future requirements.

"We have consumed practically all of our reserve capacity and are in a much worse position today to fight a major war than we were in 1940 when we had 25 percent spare refining and crude oil capacity," said Burrill stressing the vital need for flexibility.

Burrill estimated that maximum refinery runs that can be maintained for the first quarter will be 6.7 million barrels daily, an increase of only 1.8 percent over the preceding quarter.

Houdry Executive Panel Reorganized at Election

Houdry Process Corporation has elected new executive officers headed by Chalmer G. Kirkbride, president.

Peavy

Kirkbride

Claude C. Peavy has been elected vice chairman of the board, and Clarence H. Thayer, Sun Oil Company, vice president of manufacturing. The election was a reorganization move to intensify the promotion of processes licensed by Houdry. Kirkbride has been vice president in charge of Research and Development, and Peavy vice president in charge of Engineering and Sales.

First 1952 Session Held By WPRA at Beaumont, Texas

The joint technical-industrial relations session, Western Petroleum Refiners Association, was held in Beaumont, Texas, early this month. R. B. McHenry, employe relations director of Gulf Oil Corporation at Port Arthur, Texas, presided over the session on industrial relations. Paul D. Williams, WPRA technologist, presided over the technical session.

Industrial relations addresses were given by: L. C. Newton, Skelly Oil Company at Tulsa, on "An Analysis of Labor Arbitration Cases"; T. G. Hanlon, Pan-Am Southern Corporation at New Orleans, on "A Program of Salary Administration"; E. W. McNeil, Esso Standard Oil Company at Baton Rouge, on "Refinery Training Techniques."

The four technical papers presented were: "Significance and Interpretation of Bureau of Mines Routine Crude Analysis," by C. M. McKinney, U. S. Bureau of Mines at Bartlesville, Okla.; "The Stability of Present Day Gasolines," by R. O. Bender, E. I. du Pont de Nemours and Company at Wilmington, Del.; "Catalytic Unit Reactor Failure," by Vernon G. Ploeger, Humble Oil and Refining Company at Baytown, Texas; and "Sulfur Recovery," by J. L. Parker, Girdler Corporation, Tulsa.

Du Pont Names Promotions In Petrochemicals Division

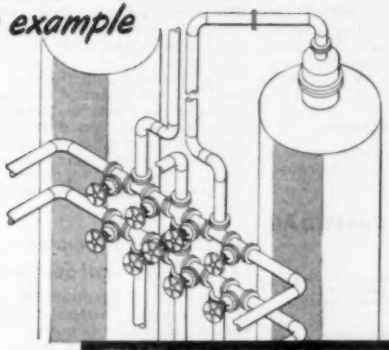
Four members of Du Pont's Petroleum Chemicals Division who were advanced to new posts last month were:

T. Baldwin Prickett was named planning manager; Robert F. Harwick became sales promotion manager; Richard O. Bender was appointed assistant technical manager; and Arthur F. Bowe, formerly manager of the Eastern District Laboratory, at Deepwater Point, N. J., was appointed laboratory coordinator.

Prickett came with Du Pont in 1946

Are You Getting Valve Satisfaction?

Like this Refinery for example



THE INSTALLATION

Nine Crane valves on control manifold to reaction chambers on Perco Cycloversion Unit. Bareco Oil Company, Wichita, Kansas.

VALVE SERVICE RATINGS

SUITABILITY:	Matches service needs
MAINTENANCE COST:	None to date
CORROSION-RESISTANCE:	O.K.
SERVICE LIFE:	Now more than 2 yrs.
OPERATING RESULTS:	Valve leakage stopped
PRICE:	In line
AVAILABILITY:	Local Crane supplier

THE HISTORY

Valves formerly used would not stay absolutely tight as necessary. Down time for repairs was excessive. Fluids handled: At oil inlet, straight run gasoline at 950 Deg. F., 85 psi; for catalyst regeneration, air-steam mixture at 850 Deg. F., 15 psi; regeneration waste gases, 1200 Deg. F. at 5 psi. Approximately 15-day cyclic operation.

Replacement made with Crane Valves. After more than 2 years' service, with no maintenance required, all Crane Valves are absolutely tight and operating at highest efficiency.

THE VALVE

Crane 300-Pound No. 5 Chrome-Molybdenum Alloy Steel Wedge Gate, with Stellite seats and patented flexible disc design. One of the complete Crane steel family for refinery services. See your Crane Catalog or get full data from your Crane Representative.

The Complete Crane Line Meets All Valve Needs. That's Why,

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The Month . . .

as a petroleum refining consultant; Bender was named head of the Du Pont Chemical Division petroleum laboratory in 1941; Bowe joined Du Pont in 1947 as manager of the Eastern District Laboratory.

Coal Hydrogenation Process "Too Clumsy For Survival"

Pronouncing coal hydrogenation technology to be complex and clumsy, Eugene Ayres, Gulf Research & Development Company judged the process to be "dead." He stated that fuel technologists are convinced that difficulties of coal hydrogenation are inherent and that no substantial improvement can be expected from development work, but he said that certain parts of the process will be utilized.

Ayres predicted that the exploitation of oil shale can be expected to mature by 1965 but that only about 350 million barrels can be expected from that source annually due to limited water supplies in the oil shale states.

Coal utilization will be well under way by 1970, he said, and operating on a tremendous scale by 1980 through use of low temperature carbonization, gasification, and Fischer-Tropsch processes.

He predicted the world supply of oil would fall short of demand by 40 percent in 1980 with international competition for oil growing acute and serious. Peak production of oil, said Ayres, should come about 1985 with a production better than 7 billion barrels.

Chem-Engineering Practice School Semester Begins

A new practice school program arranged by Tulane University and Pan-Am Southern Corporation, and believed to be the first of its kind in the South for chemical engineers, will be offered beginning this month as an option to outstanding students of chemical engineering during the last half of their senior year. It will be conducted at Pan-Am's Destrehan refinery, where special quarters have been provided by the company.

Plans call for the students to be assigned original investigations of a developmental or technical service nature. The problems will not be routine, but will be problems actually confronted in the operation of Destrehan's refinery, according to Dr. Gilkerson. Pan-Am's Technical Department will make available to the students the material necessary to work toward a solution to these problems.

Industry Sees Alleviation Of Strict TEL Regulation

Ethyl Corporation officials have expressed hope that the metallic lead stockpiling program will be completed some time this year, and that the company will be able to supply its customers without difficulty. In Washington, Deputy PAD Bruce K. Brown issued a statement proclaiming continuation of tetraethyl lead regulations following expiration of the current order on February 29. Brown declared the national stockpile must be built up to even greater capacity.

Max Bruner Given Charge Treco Field Construction

Max T. Bruner, chief engineer for Refinery Engineering Company, Tulsa, has been promoted to a position in charge of field construction with responsibility for inspection and supervision of all construction work and coordination of field work with the Tulsa office. Bruner has been with Treco since late 1942, stationed in Ashland, Ky., and Chicago before his transfer to Tulsa in 1947. In 1949 he became chief estimator in addition to chief engineer in charge of engineering design. Expanded activity due to catalytic cracking advancements in 1950 led to his promotion to chief engineer.

Bruner

Increased Steel Allowance

Oil industry branches receiving second quarter increases in steel allocation were: natural gas production and processing, refining, marketing and production. The refining industry, which received 150,575 tons of steel during the first quarter, was allocated 158,472 tons for the second quarter.

THE OIL MAN'S CALENDAR

FEB. 29	Natural Gasoline Assn. of America (Permian-Basin Regional), Odessa, Texas, Lincoln Hotel.
MAR. 3– 7	ASTM, Spring and Committee Meeting, Cleveland, Ohio, Hotel Statler.
8–10	Southwestern Gas Measurement Course, U. of Oklahoma, Norman.
10–14	Natl. Assn. of Corrosion Engineers, Annual Conference and Exhibition, Galveston, Galvez Hotel.
16–19	AIChE, Regional, Atlanta, Biltmore Hotel.
31 to Apr. 2	WPRA, 40 Annual, San Antonio, The Plaza Hotel.
APRIL 16–18	National Petroleum Association, Semi-Annual, Cleveland, Hotel Cleveland.
29–30	American Oil Chemists' Socy. (Spring Meeting), Houston, Shamrock Hotel.
30 to May 2	Natural Gasoline Association of America, Annual, Houston, Rice Hotel.
MAY 11–14	AIChE, Regional, French Lick, Ind., French Lick Springs Hotel.
12–15	API, Div. of Ref. Midyear, San Francisco, St. Francis Hotel.
12–15	LPGA, Annual, Chicago, Palmer House.
26–28	AGA, Production and Chemical Conf., New York, Hotel New Yorker.
JUNE 23–27	ASTM Annual, Exhibit of Testing Apparatus and Laboratory Supplies, New York, Hotels Statler; New Yorker.
SEPT. 8–12	ISA Conference and Exhibit, Cleveland.
10–12	National Petroleum Assn. (50th Annual), Atlantic City, The Traymore.
OCT. 9–10	California Natural Gasoline Assn., Annual, Los Angeles, The Ambassador.
20–24	National Safety Council, National Safety Congress and Exposition, Chicago, Conrad Hilton Hotel.
Wk. of Oct. 27	AGA Annual, Atlantic City, Auditorium.
NOV. 10–13	API Annual, Chicago, Conrad Hilton Hotel and Palmer House.

Industry Defended Against "Concentration" Charges

Dr. Robert E. Wilson, Standard Oil Company (Indiana) board chairman, has spoken out against critics who complain that big business concerns are swallowing up the national economy. Dr. Wilson stated that economic concentration in business is decreasing rather than increasing, and that small businessmen are busy worrying about big government rather than big business threats. He compared the great fervor and repetition of discredited charges of concentration to the Hitler theory of the Big Lie.

He branded "interlocking directorates" as an element of the smear technique and a waste of money; charged "oligopoly" was absurd when applied to the oil industry which probably contains more competing sellers in any given market than could be recruited for any other commodity excepting food products.

U. S. Rubber Promotes Two in Chemical Section

Two major organizational changes in the Naugatuck Chemical division, United States Rubber Company, concerned Clayton F. Ruebensaal, formerly technical director, plastics, and resins, for the division, who was named to the newly-created position of commercial development manager, and Dr. D. Lorin Schoene, formerly manager of organic research, who was named to succeed Ruebensaal as manager of plastics development.

Ruebensaal was one of the organizers of the chemical division of the Glenn L. Martin Company, and was, in large part, responsible for the initial research, development and production of Marvinol polyvinyl chloride resins.

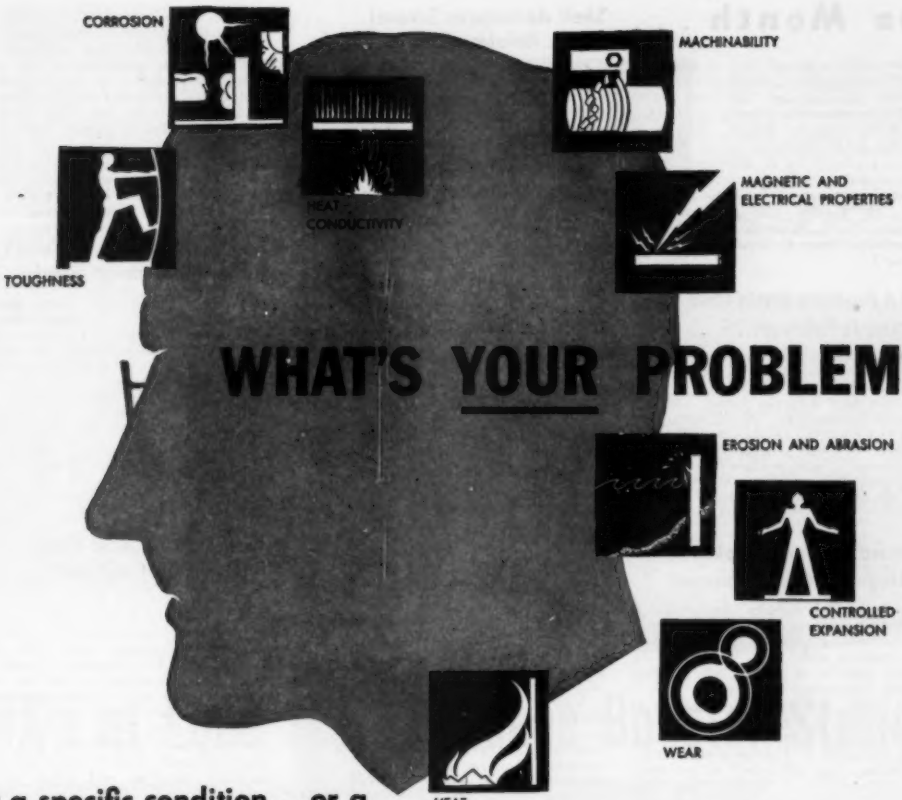
NGAA Testing Program Tests Accuracy of Analyses

Improvement in accuracy of analysis will be evaluated shortly by the Fractional Analysis Committee of the Natural Gasoline Association of America in a testing program already being carried out. Two liquid samples have been distributed to 61 oil companies and commercial laboratories participating in the research program. The current project is confined to analytical problems at natural gasoline plants and paraffinic hydrocarbon mixtures, but laboratories having similar or more complex mixtures are welcome to participate according to the NGAA.

Results of the current analytical series will be reported at the NGAA convention at Houston in April when a seminar on the subject will be held.

PAD Changing Top-Level Officials This Spring

Several changes within the Petroleum Administration for Defense will be effected this spring. Assistant deputy A. P. Frame, Cities Service, will move



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The Month . . .

into the newly-created post of associate deputy administrator, created to retain departing officials in high-level posts while replacements are being acquainted with PAD routine. Frame, who will leave the PAD organization on April 1, is being replaced by C. E. Davis, Shell Oil Company. Davis, formerly refining director of the agency, will be replaced by W. W. Keeler, Phillips Petroleum Company. J. E. Warren, Independent, will replace Bruce K. Brown as deputy on June 1.

NGAA Permian Basin Unit Meeting Is February 29

The Permian Basin regional meeting of the Natural Gasoline Association of America will be held Friday, February 29, in the new Lincoln Hotel, Odessa, Texas, according to W. L. Phillips, Phillips Petroleum Company, Odessa, chairman of the program committee. The program will feature discussions of particular interest to West Texas plant operators, notably sulfur extraction.

Standard (Indiana) Makes Whiting-Neodesha Changes

Standard Oil Company (Indiana) has announced multiple personnel changes by promotion. Promoted to the rank of group leaders were J. A. Anderson, D. S. Gray, and V. A. Smith, all Whiting research laboratory employes.

J. C. Bailie, assistant chief chemist at Whiting research laboratories, was promoted to chief chemist at Neodesha, Kans., while W. J. Tancig, group leader at Whiting, was advanced to assistant chief chemist. H. V. Knight has been transferred to the manufacturing department at Neodesha, leaving the post of chief chemist to Bailie.

A. H. Fox, group leader, was named a research associate in the automotive research division at Whiting.

Paulus Gets New Order

Under a change in executive organization of Standard Oil Company (Indiana), Dr. M. G. Paulus, vice president of manufacturing, reports to F. O. Prior, executive vice president, instead of A. W. Peake, president.

Shell Announces Several Public Relation Changes

G. Gordon Biggar, formerly assistant manager in charge of special projects, for Shell Oil Company, has been promoted to manager of public relations, with offices in New York.

Pearson

Biggar

Roberts

Mulvaney

McCoy

Also in the Public Relations department, Robert G. Pearson, assistant manager in charge of publicity, was named manager of the Publicity and Information division. Hugh F. Mulvaney, who has been responsible for Shell's public relations activities in the Southwest, with Houston headquarters, has moved to New York as manager of the Special Project division. Frederick H. Roberts, who has handled public relations art and reproduction, has assumed added responsibilities as art director and head of the Production and Distribution section. He will have New York headquarters.

V. J. McCoy has been promoted to the position of public relations field representative, succeeding Mulvaney, and will supervise activities of the various comapny branches in Harris County as well as coordinating Shell's public relations program in the Gulf Mid-continent area. McCoy joined Shell in 1943 as a training supervisor at Houston, being transferred to New York in 1945 as manager of the training division. Since 1947 he has been training representative in the Houston area.

So-Vac Names P. W. Judah Lube Department Head

P. W. Judah has been appointed manager of the Lubricating Department of Socony-Vacuum Oil Company, Inc., succeeding Paul V. Keyser Jr., who was recently appointed general manager of domestic marketing.

Judah, who has been manager of the Industrial Division of the Lubricating Department since 1949, has been associated with Socony-Vacuum since 1932, when he became a service station attendant at Elmira, N. Y. He was graduated as a civil engineer from Purdue University in 1928.

New Sulfuric Acid Plant Planned for California

Sulfuric acid will be manufactured at a new plant in Avon, Calif., which will be erected cooperatively by Monsanto Chemical Company and Tide Water Associated Oil Company. Sludge from the refining company as well as refinery gases will be used as raw materials for the new plant which will utilize the Monsanto-Ross-Wilde process for recovering acid. Tide Water will use the manufactured sulfuric acid for use in aviation gasoline and other products.

Stanolind Decentralizes Accounting Department

A decentralization program of its accounting and treasury department at Tulsa, which was initiated last year by the Stanolind Oil and Gas Company will be completed next month with the establishment of the last office at Fort Worth, Texas.

The third group completed the move from Tulsa to Houston to establish the Gulf Coast Division early this month. Offices have already been established in Oklahoma City, Central Division office, and Casper, Wyo., Rocky Mountain Division office.

R. S. Aires Opens Tokyo Branch

R. S. Aries & Associates, consulting engineers and economists, New York, have announced the opening of a branch office in Japan. H. F. Alber, chemical engineer, has been named to head the office, and Teizo Schiohara, former head of the Japanese Drug Manufacturers Association and a graduate of Princeton University is also a member of the Tokyo office.

ACF Reports Results for Year-Long Scrap Drive

The American Car and Foundry Company has collected 19,883 gross tons of steel scrap from its twelve plants during an intensive drive which started in

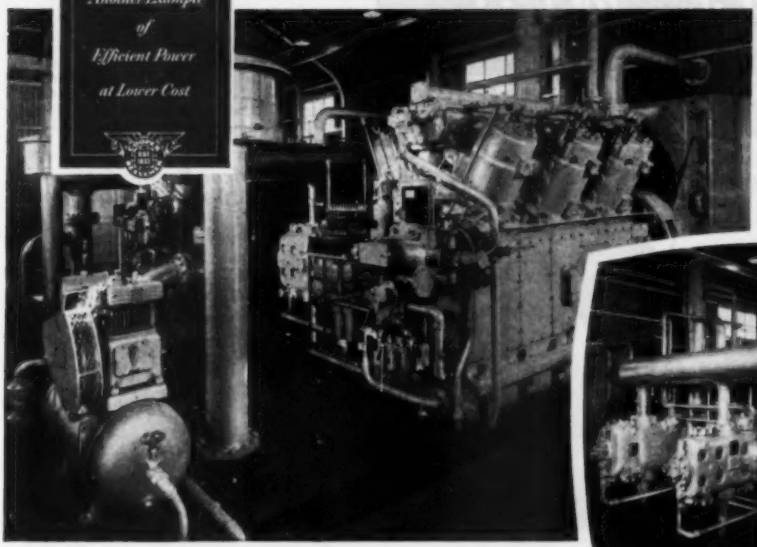
Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

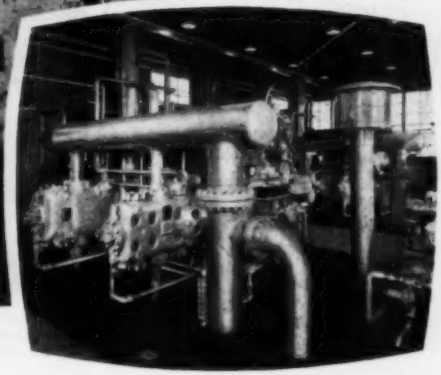
Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1951:									
January 27	6,066	6,483	244,220	21,106	126,261	9,954	58,997	9,905	40,378
February 24	5,954	6,524	237,204	20,815	136,870	10,345	48,784	9,471	38,905
March 31	6,041	6,381	235,956	20,398	142,186	9,365	43,170	9,147	37,282
April 28	6,154	6,236	242,479	19,876	137,474	8,061	43,859	8,747	36,080
May 26	6,163	6,430	246,400	21,102	130,819	8,580	51,344	9,045	37,365
June 30	6,181	6,595	247,299	21,666	126,844	8,542	65,700	9,036	41,097
July 28	6,305	6,396	251,203	21,539	121,156	8,174	76,938	8,858	44,967
August 25	6,220	6,500	252,257	21,592	115,934	8,761	85,543	8,762	46,753
September 29	6,303	6,558	255,519	21,085	112,356	9,124	97,019	8,332	47,569
October 27	6,340	6,461	250,852	22,364	111,120	9,380	102,106	8,433	49,168
November 24	6,232	6,757	260,465	22,181	111,698	9,428	98,986	9,305	47,591
December 29	6,204	6,763	256,437	22,478	122,558	10,522	83,792	9,371	43,571
1952:									
January 26	6,194	6,384	253,186	21,649	133,861	10,391	66,450	9,222	38,725

Another Example of Efficient Power at Lower Cost



Left: Two Cooper-Bessemer skid-mounted GMX-6 compressors in Lone Star's Abilene Booster Station. Station is piped for either east or west delivery. Units are equipped to provide proper unloading to permit broad flexibility in meeting pressure conditions.

Below: Compressor cylinder side of above skid-mounted units. Floor line is flush with tops of skids resulting in conventional floor appearance and simplicity.



GMX's at Lone Star's Abilene Booster Station

...2 "packages" of flexibility

IT MIGHT surprise you to know that the GMX's pictured opposite are skid-mounted units . . . 2 packages, factory tested and delivered complete with all auxiliary equipment. It's quite an advantage —made possible by the simplicity and extreme compactness of these modern Cooper-Bessemer compressors.

Secondly, and perhaps even more remarkable, is the unusual flexibility of this compressor set-up. The station is piped so that it can pump either east or west —necessitating compressors that would operate efficiently despite widely varying pressure conditions. These GMX's readily provided with the proper unloading facilities to permit such flexibility. And, with suction pressures running lower than anticipated, months on end, it's another example of how well GMX's can handle tough jobs.

If you have a compressor job coming up, tough or simple, get all the money-saving facts on modern, long-lived Cooper-Bessemer V-angles—GMX's, GMV's and GMW's. They're ready to cut your costs on any compressor requirement from 200 to 3,000 hp.

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No more "off the cuff" decisions when you compare blower values

- ☐ Choice of Rotary or Centrifugal
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- ☐ Easy accessibility
- ☐ Ruggedness
- ☐ Ease of installation
- ☐ Ability to handle overloads
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- ☐ Freedom from breakdowns
- ☐ Low maintenance costs
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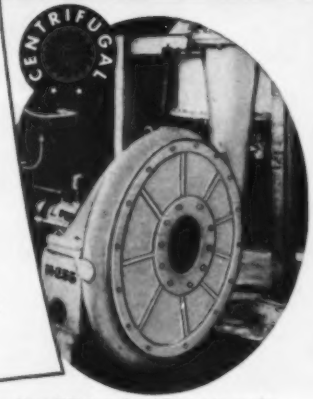
- ☐ Customer satisfaction



Type OIB Centrifugal Blower in use by southern petroleum company. Capacity 2,000 cfm. Motor driven through gear.

If you are considering new equipment for handling gas or air, we suggest you examine the essential values listed above, before you make your final selection. These factors will help you determine the unit that will best match your specific application, and that will give you the most satisfactory, economical performance.

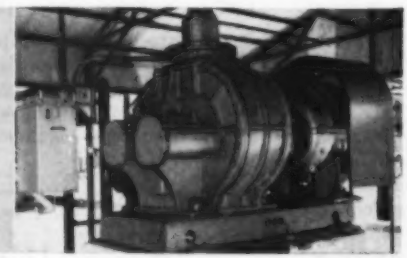
You'll find that R-C equipment rates high in every one of these essential factors. With capacities ranging from 10 cfm to 100,000 cfm or higher, at moderate pressures, and with the exclusive *dual-ability* line of Centrifugal or Rotary Positive types, you have a wide choice to meet the most exacting needs.

If you'd like to tell us about your specific problem, we'll gladly send detailed information for comparison, or supply engineering help from our 98 years of blower building experience.

ROOTS-CONNERSVILLE BLOWER CORPORATION
522 Crescent Avenue, Connersville, Indiana

ROTARY

Type RCD Rotary Positive Blower for producing low-pressure air for asphalt oxidation still. Driven by squirrel-cage motor. Capacity 2,850 cfm.



Reg. U. S. Pat. Off.

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

The Month . . .

January, 1951. ACF cleaned up its shops by disposing of all scrap machinery, dies, formers and other loose scrap around the plants; a special representative was appointed to inspect the various plants and make a survey of obsolete industrial equipment which could be scrapped.

Pan American Reorganizes Research-Development Unit

New research objectives and development of a more flexible organization have occasioned a number of changes in the Research and Development Department of the Pan American Refining Corporation at Texas City.

Dr. H. D. Radford has been named head of the Process Development Section, and Dr. F. T. Wadsworth has been appointed head of the newly formed Chemicals Section. J. A. Ridgeway has been named research associate. J. A. Grant has been promoted to the position as head of the new Chemical and Instrumental Section of the Analytical Division.

The Analytical Division has been enlarged in the reorganization, and will continue under the direction of Dr. G. W. Jack, chief chemist. C. J. Robinson has been promoted to group leader in the Chemical and Instrumental Section, and Gene Stoneburner has been advanced to the position of supervisor of the non-technical group of the Analytical Division.

J. A. Wilk has been appointed head of the enlarged inspection group of the Analytical Division, with C. M. Wolston named supervisor of the Inspection Laboratory. D. B. Meyer has been advanced to the position of group leader in the Process Design Section of the Development Division.

Rapid AIOC Expansion Relieves Abadan Strain

Associated Anglo-Iranian refineries in Europe have doubled their collective capacity to about 180,000 barrels daily to compare with 85,000 barrels capacity a year ago. Company officials point out that this increased capacity partially makes up loss of the 508,000 barrel daily plant at Abadan which the Iranian government took over last Fall. Principal capacity increases stemmed from the new 41,200 barrel refinery at Antwerp and the new distillation and ancillary units at Dunkirk which have increased the capacity there to 42,000 barrels daily.

B-A Names J. W. Morgan As Montreal East Manager

The British American Oil Company has appointed J. W. Morgan manager of its Montreal East refinery, succeeding the late R. F. A. Smith.

Morgan joined British American at Calgary refinery in 1939, and held several positions in the manufacturing department before being appointed assistant manager of the company's Moose Jaw plant last year.

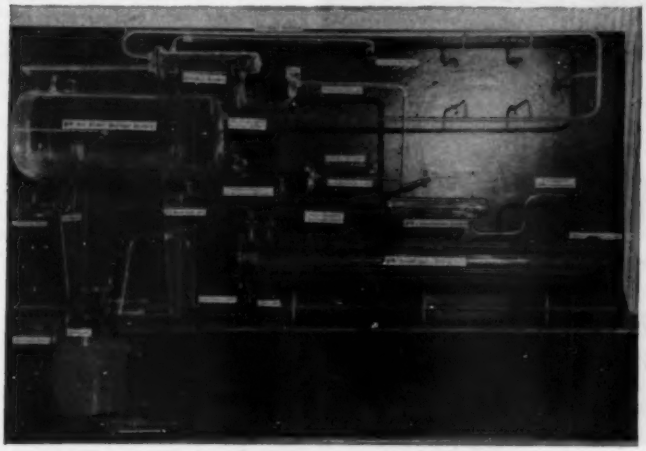
Clapp Lab Gets New Head

The William F. Clapp Laboratories, Inc., at Duxbury, Mass., will be directed by A. P. Richards who was elected president and named a director at a

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Plastic model of a hot process water-heating system for laundries, textile plants and process industries. Saves 30 to 60% fuel. Relieves overloaded boilers. Courtesy: The Patterson Kelley Company, Inc., East Stroudsburg, Pa.

Reclaiming Waste Heat Pays Big Dividends

Since every cloud of steam escaping into the atmosphere and every discharge of warm liquids into sewers represents loss of valuable heat, it is no wonder that much thought is being given to the recovery of waste heat which may represent from 30 to 60% of the fuel used for generating steam.

Lower Fuel Bills

Every plant using an abundance of hot water or steam for processing, washing, cooking, sterilizing, heating, etc. is a potential prospect for making worth-while savings in its fuel bill and thereby reducing its cost of operation. In many instances the cost of special equipment for reclaiming waste heat will pay for itself in one or two years and represents an excellent investment.

The illustration above shows a plastic model of a water heating system for laundries, textile plants and process industries. Laundries generate steam and use about two-thirds of it for making hot water and the balance for presses, flatwork ironers and driers. The production of hot water represents the highest cost of operation. To reduce the cost of heating water it is necessary first to reclaim the heat from the hot waste water; second, the heat from exhaust steam; and thirdly, from high pressure condensates.

The hot water which ordinarily drains through the sewer and has a temperature between 120 to 130° F is first drained through screens to hold back foreign matter and is discharged into a sump from which point it is picked up by a non-clog, self-priming pump which forces the water through the tube of a closed type reclaimer.

Heat Salvaged from 4 Sources

Incoming fresh, clean water is circulated on the outside of the tubes, which are generally made from copper. The temperature of the waste water in the exit end of the reclaimer drops between 70 to 80° F and brings up the temperature of the fresh water entering between 40 to 55° F to from 90 to 110° F. After it leaves the reclaimer the waste water is discharged to the sewer while the heated fresh water goes to the condensate cooler. Here it picks up heat from the condensate, from high pressure steam from the machine, and from the booster heater in the plant. It then goes to the hot water storage heater. Exhaust from the steam water is condensed through a copper tube nest in the storage heater and raises the temperature of the water in the storage tank to approximately the temperature required for processing.

Temperature and Pressure Held Constant

A circulating pump is used to discharge water from the storage heater to the booster heater, to maintain a constant temperature, generally 180° F, and a constant pressure to the washroom or processing machine. This water is continually circulated to maintain a uniform temperature and pressure.

Coils of tubes are either of copper or Admiralty brass or one of the other condenser tube alloys depending on the corrosive nature of the waste liquid. Duplex tubes are required whenever two different corrosive liquids are involved. Duplex tubing can be made in various combinations of materials to offset most kinds of double corrosion conditions. Combinations of Admiralty brass, aluminum bronze, aluminum brass, copper, cupro nickel, Muntz metal, naval brass, silicon bronze, aluminum, lead, nickel, low-carbon steel and stainless steel are popular. (7881)

There's a KEMP DRYER for every Moisture Problem

Dry air, gases, liquids to sub-zero dew points . . . at minimum cost

Quality, diversity, flexibility, economy . . . four good reasons why Kemp Dynamic Dryers offer you the *best* solution for *any* moisture problem. Kemp superiority of design and engineering know-how is your assurance of *dependable, low-cost* performance whether you dry air, gases or liquids. Many Kemp users report drying to sub-zero dew points for as little as ¼¢ per mcf—including all charges for labor, capital investment and materials. In addition, Kemp guarantees operation of every unit to meet your specifications.

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RADIATION COOLED—For small or medium flow rates. Offer low operating cost with maximum efficiency.

CONVECTION COOLED—Provide continuous drying capacity of air and gases at minimum cost.

*All of above in complete range of sizes with manual, semi-automatic or fully automatic operation.

Kemp Engineering Versatile

Gas, electric or steam regeneration is standard equipment with every Kemp Dynamic Dryer . . . with or without cooling units. Also, depending on your needs, you have a choice of manual, semi-automatic or fully automatic operation. In every instance, Kemp will specify the proper dessiccant suitable for your operation. Chances are there is a standard Kemp design that is ideal for your plant and saves you money too. It costs you nothing to investigate.

KEMP
OF BALTIMORE

DYNAMIC DRYERS

For technical information and facts on how Kemp Dryers can solve your moisture problems, write for Bulletin D-27 to:

THE C. M. KEMP MFG. CO.
405 E. Oliver St., Baltimore 2, Md.

The Month . . .

recent board meeting. The election was necessitated because of the recent death of Dr. William F. Clapp. Richards had been Dr. Clapp's assistant for the past 16 years and was nominated by Dr. Clapp as his successor.

Latest BOM Report Mere Revision of Original

The latest government report on commercial production of synthetic liquid fuels from coal was challanged as "misleading" by the Synthetics Fuels Committee of the National Petroleum Council which reported a cost figure of 12 cents a gallon for gasoline production should actually be 41 cents.

Committee chairman, W. S. S. Rodgers, The Texas Company, declared the coal hydrogenation proposal "fantastic and out of the question." The committee made its report after studying the November 19, 1951, cost analysis released recently by the Bureau of Mines. The plant proposed in the latest Bureau report could not be classified as a liquid fuels venture, said the committee, because chemical production accounted for more than half of the total revenue.

Truman Urges Snythetics—Omits Budget Provision

In his budget message for the 1953 fiscal year President Truman stated that "research and operation of pilot and demonstration plants for production of synthetic liquid fuels from oil shale and coal will be continued." However the budget he presented did not provide for further expansion in that direction. The request for 1953, $7,630,304, showed only slight increase over the estimated $7,433,704 which will have been spent on the program by June 30. Further remarks hinted that more funds might be secured from the borrowing authority which he proposed increased by another $900 million.

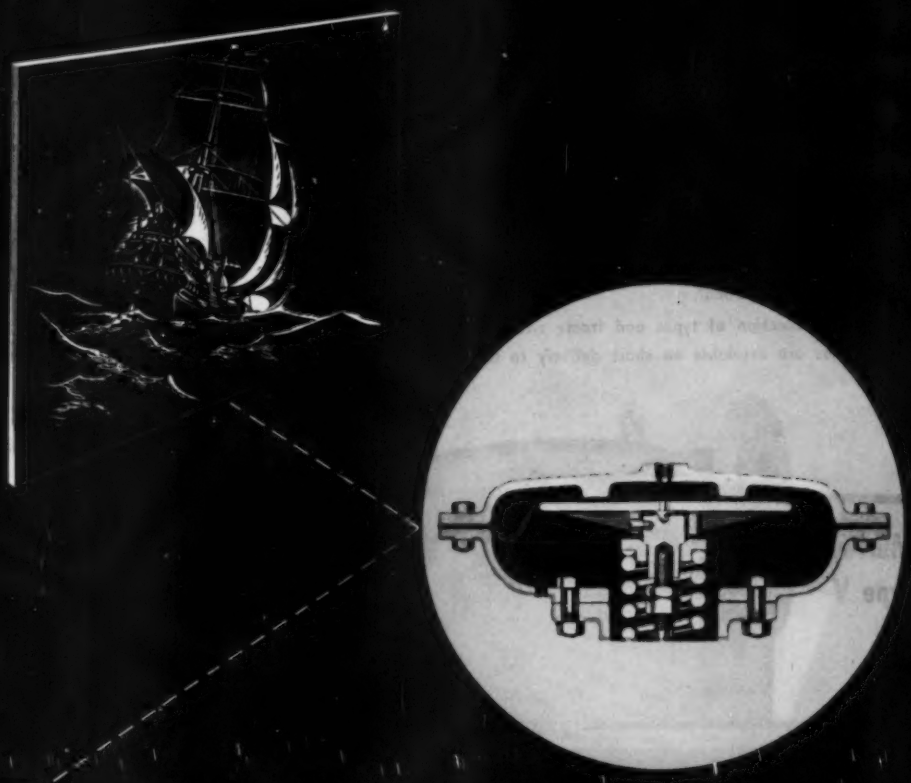
Funds for such agencies as the Petroleum Administration for Defense and the Defense Production Act authority, which expire June 30 under present law, were not mentioned. PAD has requested $3,435,000 for the 1953 fiscal year, and the request is before the Bureau of the Budget. During the 1951 fiscal year the agency received $985,120 and will have spent an estimated $2,431,100 by June 30.

National Research Adds Dr. James Gardner to Staff

Dr. James H. Gardner, who recently joined the Petrochemical Research Department at National Research Corporation, Cambridge, Mass., received his B.S. in chemical engineering from the University of Utah in 1947 and in 1950 received his Ph.D. from Harvard University.

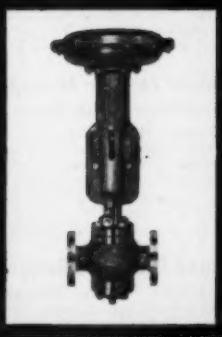
Gardner

Subsequently, Dr. Gardner was employed as a technologist by Shell Oil Company at Deer Park, Texas, and as



ROLLING ACTION . . .

for superior spring-diaphragm characteristics



The pre-moulded neoprene diaphragm in the Honeywell Series 700 Valve features rolling action . . . eliminates wrinkling or buckling . . . responds to slightest change in signal air pressure . . . may be used with either air or gas as actuating medium. The Honeywell Series 700 Valve is available in a wide range of styles and sizes . . . has *all* the features you look for in a fine valve. Write today for your copy of Bulletin 700-3.

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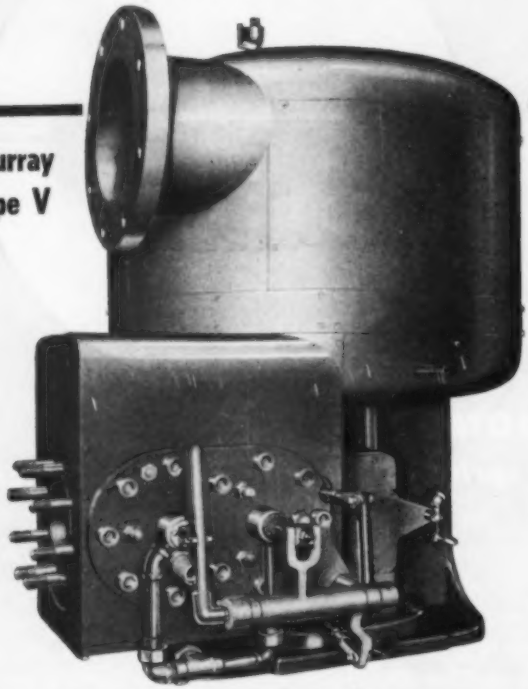
Steam turbines provide safety, low maintenance expense and ability to operate for long periods without inspection. Unsheltered installations are highly practical.

A large selection of types and frame sizes, special features and accessories are available on short delivery to suit your application.



Murray Type V

Among the newest in the Murray turbine line is the Type V vertical turbine, above. This machine provides completely enclosed construction, either direct-connected or geared for vertical pumps up to 600 HP and beyond. See that your new vertical pump is driven with a Type V steam turbine.

Contact your nearest Murray representative or write direct to—

MURRAY IRON WORKS COMPANY

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Builders of Steam Power Equipment for Three Quarters of a Century.

The Month . . .

a lecturer in the Chemical Engineering Department at the University of Houston. He will supervise the physical chemistry phases of the petrochemical research program undertaken jointly by National Research Corporation, Electric Bond and Share Company and United Gas, directed toward the development of new chemicals from natural gas.

Conoco Advances Govreau To Manufacturing Division

C. P. Govreau, manager of operations in Continental Oil Company's petrochemical plant at Baltimore, Md., has been promoted to assistant manager of the manufacturing department, Houston.

Govreau, born in Rocky Ford, Colo., attended Colorado College at Colorado Springs, and joined Continental in a clerical position at Denver in 1927.

Promoted and transferred to the general offices in Ponca City, Okla., in 1929, Govreau advanced through several positions at Ponca City and Baltimore, becoming superintendent of the Baltimore plant in 1950. He was named manager of operations there in June, 1951.

Du Pont Appoints Towery Houston Chemicals Head

Du Pont Petroleum Chemicals Division has appointed Charles D. Towery manager of the Gulf Coast District with headquarters in the Bank of Commerce Building. Towery has been associated with the Division since 1947, first as sales service representative and later as manager of the Mid-continent district. He formerly was employed by Bethlehem Supply Company of Houston, and served as a petroleum advisor in the U. S. Navy during the war.

Ries Appointed Whiting Plant Research Associate

Herman E. Ries, Jr., has recently been appointed research associate in the Whiting Research Laboratories of Standard Oil Company (Indiana). Dr. Ries received his Ph.D. in chemistry from the University of Chicago and has been associated with the Sinclair Refining Company for the past 15 years.

Standard Indiana Names Reppen New Group Leader

Harold E. Reppen has been promoted to group leader in technical service at the Whiting, Ind., research laboratories of Standard Oil Company (Indiana). Reppen joined the company in 1943 as a chemical engineer following graduation from the University of Illinois.

Ashland Executive Resigns

J. Howard Marshall has resigned as vice chairman and director of the Ashland Oil & Refining Company and will engage in legal and operating phases of the oil industry.

Ed Guidinger, Phillips, Retires After 26 Years

Edward F. Guidinger, consultant to C. R. Musgrave, vice president supply and transportation, Phillips Petroleum

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Maximum coordination between men, machinery and materials — the only answer to economic purchasing. These factors lower Western's fabrication costs and make their heat transfer equipment available to the petroleum, chemical and pipeline industries at a minimum price consistant with quality.

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Western's Engineering Department is available to "tailor" any type of heat exchanger to the specific problem faced. Close attention to engineering details and specifications assure long and serviceable life on all telescopic exchanger, shell and tube exchangers, atmospheric sections and re-boilers fabricated by Western.

Yes, it all adds up to more economical operation, more PROFIT for you. The secret is WESTERN SERVICE . . . a service that deals with YOUR specific company . . . YOUR specific heat transfer problem, from sales contact to final installation. Now is the time to check your operational and maintenance records. If new installations or replacements are needed, contact your nearest Western representative. He will give you the complete picture on Western's outstanding engineering and fabrication facilities. Remember . . . WESTERN means DEPENDABLE SERVICE on all your heat transfer problems.

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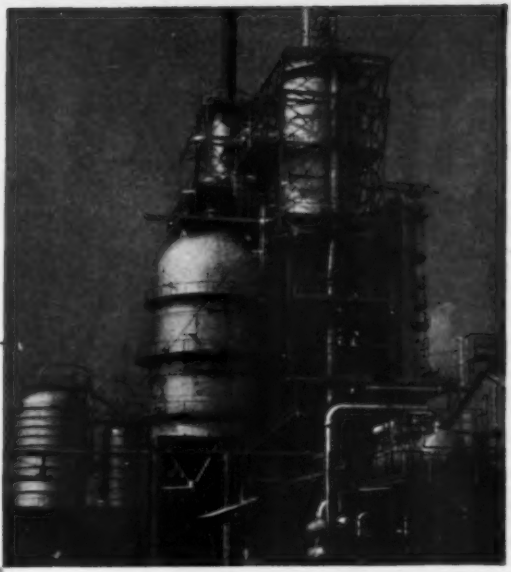
Cat-Lube* does double duty for Sohio



Sohio's continuous contact filtration and catalytic cracking units

The Sohio lube finishing unit represents the most advanced engineering concept for the continuous contact filtration process. In this plant, operating and maintenance costs are reduced and capital investment was lowered as compared to earlier installations.

Fluidized handling of the adsorbent permits a dust-free operation and hence a marked improvement in unit housekeeping. These are obvious important advantages but Sohio has added to them equally important economies through the use of Filtrol's Cat-Lube (Adsorbent Catalyst).

FILTROL DOUBLE-DUTY CAT-LUBE IMPROVES MAJOR OPERATING ECONOMIES

Filtrol Cat-Lube at Sohio's Lima plant does double duty. After bringing the finished oil to high specifications demanded of the decolorizing step at the lube plant, the spent adsorbent filter cake is slurried with fresh cat cracker feed and pumped to the fluid catalyst cracking unit. Although this unit is not equipped with a precipitator, activity maintenance is good and the "cat cracker" has continued to show a high level of performance.

Write for full information on Cat-Lube

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Filtrol CATALYSTS AND ADSORBENTS

*T. M. REG. U. S. PAT. OFF.

The Month . . .

Company, is retiring after more than 26 years of service with that company. He received his B.S. degree from the University of Nebraska in 1908 and spent several years in the East, before going to Bartlesville in 1912 to work for various oil companies. In 1919 he went into business for himself.

In 1925 Guidinger joined Phillips as petroleum engineer, and by 1932, he was given charge of crude oil sales and pipe lines. Later he became executive manager of crude oil pipe lines, and consultant to Musgrave.

Chemicals Pioneer Dies

James A. Rafferty, vice president and director of Union Carbide and Carbon Corporation, died recently at Fort Lauderdale, Fla. Rafferty was a pioneer in the development of the synthetic organic chemical industry in the United States, built up largely under his direction since 1920. During World War II he was executive official in charge of the extensive operations of Union Carbide in behalf of the government's wartime synthetic rubber and atomic energy programs.

Harry Kelly, Gulf, Dies

Harry J. Kelly, who retired as manager of the construction and maintenance division of the manufacturing department of Gulf Oil Corporation on December 31, died suddenly January 21. Kelly joined the Gulf companies in 1916 when he was employed in the construction division of its Port Arthur, Texas, refinery.

Gulf Veteran Dies

Joseph A. Pellettere, Gulf Oil Corporation chemical engineer, died last month. Pellettere had been employed by Gulf since 1922, shortly after graduating from Rice Institute. Since 1935 he had been stationed at the company's home office in Pittsburgh.

LETTERS

OK's Anson Article

To The Editor:

Although some time has elapsed since I received the December issue of PETROLEUM REFINER, I feel that a comment is still in order concerning an article which appeared therein.

I refer to Dr. I. A. Anson's article "The Engineer's Special Interest In Finance." I read it immediately and was so impressed that I asked my wife to read it also. She did and shared my opinion that it was an excellent bit of advice and well worth reading. I am sure that Dr. Anson's article will do much toward shaping the thinking of many young engineers with respect to their attack on the future.

Rarely, if ever, does one find such an article, in or out of technical journals, and I sincerely hope that the publishers of the "Refiner" will see fit to print more of the same—even though the subject matter may seem to deviate from the purpose of the magazine.

(signed) George Jandacek
8622 So. Loomis
Chicago

UNIQUE NEW Sier-Bath External Gear & Bearing Bracket Type SCREW PUMP

RUGGED BRACKETS won't twist rotors out of alignment.

THRUST BEARINGS for less wear on bearings and timing gears. Double-row angular contact ball bearings position rotors axially.

INTERCHANGEABLE ROTOR SCREWS make major overhauls simple, inexpensive—greatly reduce need (and expense) of periodic pump replacement.

FOR non-lubricating fluids, semi-fluids. Capacities 1-700 GPM; Discharge 1000 PSI for viscous liquids, 500 PSI for water. Also available in Hopper and Liner Types.

SINGLE-POINT ALIGNMENT speeds servicing—eliminates rotor distortion during installation, or when handling hot material.

ROLLER BEARINGS where they're needed—at point of high radial load.

RIGID BEARINGS outboard of timing gears prevent shaft "whip"

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New Catalogs AND EQUIPMENT LITERATURE

For copies of the catalogs and new equipment literature listed, use one of the convenient Reader Service Postcards on this page. Just circle the number on the card corresponding to the number of the item in which you are interested.

Carbon Removal

Magnus 751 is produced by Magnus Chemical Company to remove carbonaceous deposits from the tubes of fuel oil heaters without dismantling the equipment. Cleaning is accomplished by exposing the deposit on the tubes to the action of 751.

Circle No. 1 on Postcard

Heat Insulation

A booklet containing new information about the use of hydrous calcium silicate insulation has been compiled by the Kaylo Division of Owens-Illinois Glass Company. Depicted are industrial and commercial uses for Kaylo heat insulation for temperatures as high as 1200° F.

Circle No. 2 on Postcard

Packing Glands

Packing glands designed for general use and ease of installation in process control, pilot plant or laboratory installations, have been announced by Conax Corporation. Made of stainless steel, they are available to accommodate tubes from ⅛ to 13/32 inch O.D. Two types are furnished with asbestos-graphite packing and may be used as small stuffing boxes or to seal static lines, thermocouple wells, dial type thermometer stems, or any round tubes or rods. Another type employs powdered talc as a sealant and is chemically inert.

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Industrial Equipment

The article, "High-Purity Water for Hickling Station," is featured in the Winter issue of Alco Products Review, published by the American Locomotive Company. Picture stories of heat exchanger and pressure vessel installations in the petroleum refinery fields are included.

Circle No. 4 on Postcard

Non-Frosting Gauge

Non-frosting gauges are the subject of a leaflet by Jerguson Gage & Valve Company. They are built with a special patented frost preventing unit, consisting of a flanged piece of transparent lucite in direct contact with the gauge glass. It extends the vision face beyond the cover forging so frost cannot build up across the vision slot.

Circle No. 5 on Postcard

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REFINER

BOX 2608

HOUSTON 1, TEXAS, U. S. A

PETROLEUM REFINER Reader Service Postcard—February, 1952, Issue

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MAIL IT NOW . . . CARD EXPIRES MAY 10, 1952

New Catalogs AND EQUIPMENT LITERATURE

Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested.

Water Control Valve

Manufactured by R-S Products Corporation, an S. Morgan Smith Company subsidiary, a 125-pound cast-iron valve, No. 817, consists of a 12-inch beveled vane which seats against the body side wall with a 4-inch vane mounted in the center of the larger vane. It is employed in a turbine bypass line for controlling the required quantity of water when the turbine is not in use or operating at reduced capacity. Both vanes are motor operated.

Circle No. 6 on Postcard

Lab Activity Detailed

Activity and function of each division of its laboratory is examined in Kellogram, latest issue by The M. W. Kellogg Company. The booklet details some of the research and development done in developing Fluid hydroforming, and also describes research toward perfection of Kel-F, special fluorocarbon-type plastic.

Circle No. 7 on Postcard

Fork Lift Trucks

"What Makes It Tick?" is the booklet published by Towmotor Corporation for the purpose of providing basic product information on its line of fork lift trucks. It provides a non-technical analysis of construction coupled with simple explanations.

Circle No. 8 on Postcard

General Purpose Pump

Construction details on the Allis-Chalmers Manufacturing Company's grease-lubricated, pedestal-mounted general purpose pumps, Type SSB, are given in a new bulletin released by the company. It will handle liquids at temperatures to 250° F.

Circle No. 9 on Postcard

Water Hammer Solution

Cause, effect and control of water hammer in piping systems are factors considered in a new bulletin published by The Williams Gauge Company. The bulletin indicates the potential damage to piping, instruments and other parts of water systems, and considers methods of controlling the situation.

Circle No. 10 on Postcard

Arc Welders

The new model GA "Wasp" d.c. arc welders, available in 150 and 200 ampere sizes, have been announced by Air Reduction Magnolia Company, a division of Air Reduction Company, Inc. Designed to further advance the efficient performance of the Wilson line, the volt ampere characteristics of these machines make them especially suited to d.c. straight polarity heliwelding with Thor-Tung, according to the manufacturer.

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(More Literature Items on Pages 161, 163, 165, 167, 168)

PETROLEUM REFINER Reader Service Postcard—February, 1952, Issue*

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A9	B9	C9	D9	E9	F9	G9	H9	J9	K9	L9	M9	N9	P9	Q9	R9	S9	T9
A10	B10	C10	D10	E10	F10	G10	H10	J10	K10	L10	M10	N10	P10	Q10	R10	S10	T10

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PETROLEUM
REFINER

BOX 2608

HOUSTON 1, TEXAS, U. S. A

USE THESE CARDS
To Get
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Information on
NEW EQUIPMENT ADVERTISED PRODUCTS

NEW EQUIPMENT and Manufacturers' Literature

KEEP INFORMED by requesting additional information on new equipment and services described here. SAVE TIME by using the Reader Service Postcards on opposite page. Circle number on card corresponding to the number listed at the end of each new equipment item on which you desire additional information.

Truck-Mounted Radio

An industrial truck operator at Westinghouse Electric Corporation's Appliance Division Plant is shown acknowledging an order over his truck-mounted, short-wave radio. Intraplant shipments are said to be speeded up and tightly organized by such a two-way communication, and one dispatching office can handle the entire fleet of trucks, giving orders, gathering information on supplies and location. Similar to taxi dispatching systems, the unit serves to maintain perpetual inventories of materiels as well as controlling shipments in the plant.

Circle No. 12 on Postcard

Automatic Lubricator

Elliott Company has announced a new sight-feed lubricator which assures adequate lubrication of tube cleaners and other air or steam-powered tools. Once set, this new lubricator is said to require no adjustment, being actuated entirely by pressure of the operating air or steam, not by flow. As long as pressure is supplied, oil is accurately metered into the operating hose. When operating pressure is off, oil flow is shut off tight. The rate of oil flow is controlled by a knurled cap which is backed off to increase flow, tightened to reduce it. Flow is normally set for 25 to 50 drops per minute, as observed in the sight glass.

Circle No. 13 on Postcard

Plug Valves

A new descriptive catalog covering the entire line of Porter Lubricated Plug Valves is available and provides cross-section and cut-a-way illustrations as well as line drawings of unusual features of the design. Particularly adapted for use where positive, leak-proof operation as well as corrosion resistance is necessary, the valve ranges in size from ½ to 12 inches.

Circle No. 14 on Postcard

Electric Trucks

A bulletin by Barrett-Cravens Company describing their new "Hi-Lift" Power Ox electric trucks is available, and gives specifications and illustrations of these "walkie" units which are designed for lifting, moving and stacking heavy loads. Truck capacities range from 2000 pounds to 4000 pounds with a total lift range from 121¼ inches to 68 inches. All models have electric lift and travel with push button control in the handle.

Circle No. 15 on Postcard

Thin Section Welding

A new process for welding thin sections of stainless steel has been perfected by the Rochester Manufacturing Company, Inc. The all stainless steel, dial type, bi-metallic thermometers produced by this process becomes one sturdy assembly of case, stem and conection nut. Like spot welding, no new metal is added. Photo shows how stainless steel weld replaces silver solder at stem and case. Stainless steel has high corrosion resistance not possessed by silver solder. Freedom from breakage and release of contaminating liquids, and high corrosion resistance will eliminate costly separable sockets for many process applications, predict the manufacturer.

Circle No. 16 on Postcard

Welding Couplings

Tube-Turn SF Welding couplings are described in a new folder by Tube Turns, Inc., which includes specification tables and photos showing construction and use.

Circle No. 17 on Postcard

Sight-Flow Indicator

Trin-Vue sight-flow indicator, manufactured by Trinity Equipment Corporation and marketed by Brooks Rotameter Company, is designed for checking the flow of a fluid in piping systems and for visual examination of the fluid in the line. Two windows located on opposite sides of the Trin-Vue permit maximum visibility and examination of the fluid. The windows are sealed in with O-Ring gaskets and Truarc retaining rings. A bulletin contains further information.

Circle No. 18 on Postcard

Soundproof Booth

An acoustical phone booth designed to reduce industrial noises has been marketed by S. W. Nichols Company, Inc. Known as NICO, it is light weight, portable, easy to install, and only 2x2x3 feet. It is constructed of wood with perforated hardboard and may be installed on metal or wood walls, close to any phone.

Circle No. 19 on Postcard

Flow Meter

Liquid or gas flows are easily controlled by the Brooks Mite Purge Meter manufactured by Brooks Rotameter Company. The unit is coupled with a Conoflow H-11 constant differential relay. This inexpensive assembly is designed to maintain a constant predetermined flow rate regardless of variations in either the upstream or downstream pressure.

Circle No. 20 on Postcard

It took two railroad cars to provide "passenger accommodations" for this depropanizer tower—as Sun Ship workers readied it for shipment.

tough bronco—
PETROLEUM!

Ever see a bronco at the first touch of the saddle? Ever see a gusher well come in? The resemblance doesn't end with the furious first burst of action, even though the saddled pony stands quiet . . . and the stream of black gold pours placidly into the refinery—until man renews his taming process.

Breaking a fractious horse . . . cracking petroleum . . . makes them both useful. And both tasks throw the full test of pressure on the men who tackle the job . . . and on the equipment they use.

Tanks and towers . . . in fact all refinery and chemical equipment built at Sun Ship has been meeting the toughest tests of pressure through years of service. That's to be expected. The men of Sun Ship who build it have shown their ability to meet and master the production pressure of time . . . and the engineering and shipping problems that go with the task of constructing and delivering the gigantic equipment that helps build a greater and stronger America.

Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY

To obtain additional data use free Reader Service Postcard opposite page 160. Circle number on card corresponding to number listed at the end of each item on which more data or literature is wanted.

Acid Safety Goggles

Acid safety goggles, named Duo-Chem, are manufactured by United States Safety Service Company and features a bright yellow vinyl frame, the American Standards Association color code for acids. Light weight, the frames and lens are constructed of vinyl. The one piece lens is made from special vinyl acid resistant optical plastic which will not stain or discolor from acid fumes, vapors, splashes. It is replaceable and can be removed easily. The goggles fit over personal glasses.

Circle No. 21 on Postcard

Electric Box Furnace

The Cooley Electric Manufacturing Corporation has added a new larger type BL Electric Box Furnace to its line. Formerly available in three standard sizes with working chamber dimensions of 12 x 8 x 18 inches, 12 x 8 x 24 inches, and 12 x 8 x 36 inches, this furnace is now offered with a chamber size of 15 x 12 x 30 inches. New features are the Cooley embedded type of heating unit which protects the heavy element wire from atmospheric attack; elements formed in ceramic slabs, located in each side of the furnace to give maximum and uniform heat distribution; and slab shaped elements to cause them to act as baffle walls.

Circle No. 22 on Postcard

Bellows-Type Connector

Fabricated of chemically inert Teflon, the new "John Crane" bellows type connector manufactured by the Crane Packing Company, has many pipe line applications where vibration, expansion and electrolysis exist in the handling of corrosive liquids or gases and solvents. The new connector is electrically non-conductive, flexible even at minus 94° F. and as strong at 480° F. as at 70° F., according to the manufacturer. This connector serves as a vibration dampener as well as an expansion joint, and connects misaligned couplings and insulates flanges electrically. End flanges of the joint are French-type envelope gaskets made integral with the joint for easy assembly between companion flanges and a tight, leak-proof seal on installation. A booklet is available.

Circle No. 23 on Postcard

Power Equipment

An illustrated bulletin entitled "Powerthrifty Products by Phillie Gear" is offered by Philadelphia Gear Works. It shows their line of gears, speed reducers, flexible couplings and limitorque valve controls, and specifies types and size ranges.

Circle No. 24 on Postcard

Quick Setting Cement

Permanent fixation of anchor bolts for fastening machinery, hand rails, or equipment to concrete, is said to be accomplished by use of Por-Rok Quick Setting Cement, a product of The Hallemite Manufacturing Company. This product is simple to use, as it is poured from the can without heating, into the hole holding the bolt. Por-Rok is said to be self-bonding, self-levelling, oil-resisitant, and will not shrink.

Circle No. 25 on Postcard

Locks Bolt Caps

A device providing positive locking of locknuts is being manufactured by The Security Locknut Corporation under the trade-name, Security Caploc. It affords a protection against moisture and corrosive action, to keep the nut movable. A heat-treated alloy spring steel insert within the cap acts as a locking device. Caplocs are standard except as to height.

Circle No. 26 on Postcard

Industrial Welder

A new heavy-duty direct-current welding machine is being marketed by the A. O. Smith Corporation and is designed for all industrial uses where DC welding is required. Extensive field testing has shown the new unit to be free of stack failure. This is accomplished by directing a high velocity downdraft of cool air over the rectifier stacks before passing this air through other parts of the machine, with the blast being expelled at the base of the welder. This is said to assure proper cooling and to promote internal machine cleanliness. This machine retains all principal construction features of Smith's heavy-duty AC welder.

Circle No. 27 on Postcard

Spectrometer

The Norelco Geiger-counter recording X-ray Spectrometer used for X-ray powder diffraction work and fluorescence analysis, and incorporating a novel X-ray optical arrangement which gives extremely high resolution, has been improved by the Research & Control Instruments Division of North American Philips Company, Inc. The complete assembly consists of three components: basic X-ray diffraction unit; a wide range Geiger-counter goniometer; and an electronic circuit panel with strip chart recorder. The Geiger-counter goniometer is designed to scan and analyze X-ray diffraction spectra of specimen materials by divergent-convergent beam-focusing geometry.

Circle No. 28 on Postcard

CHAPMAN LIST 960

the one Forged Steel Gate Valve that gives you this 4-WAY PROTECTION

Extra Protection Against Even Unusual Stress is provided by extra-strong stem-and-wedge-gate connection.

Repairs and Replacements Are Reduced by super-hardened seat rings and gate faces of stainless steel.

Longer-Lived Body and Yoke are of forged steel. And bolted follower has no threads on yoke to corrode.

No Seizing or Galling of Gate Faces because List 960's gates (when furnished with certain types of trim) are hardened by *Malcomizing* (patented Chapman process) to a minimum of 800 Brinnell.

An exceptionally wide range of services is covered by this small forged steel gate valve . . . giving you the same consistent top level performance on many different jobs.

Chapman List 960 Forged Steel Gate Valves are manufactured in sizes from ⅛" to 2" inclusive, and in these 2 types: (1) Rising stem with yoke (shown), and (2) Rising stem with inside screw. Bonnet joints are either gasketed or metal-to-metal. Pressure range: 2000 lb. at 100°F. — 380 lb. at 1000°F. For higher pressures, specify List 990. Send for illustrated Catalog No. 10.

THE CHAPMAN VALVE MFG. CO., INDIAN ORCHARD, MASS.

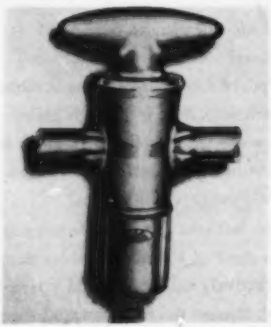
To obtain additional data use free Reader Service Postcard opposite page 160. Circle number on card corresponding to number listed at the end of each item on which more data or literature is wanted.

Rust Preventive Paint

An improved formula of its certified rust inhibitor No. 425 has been announced by United Laboratories, Inc. This new rust preventive paint dries within ten minutes under normal conditions and one coat hides any metal surface.

Circle No. 29 on Postcard

Laboratory Stopcocks



A full range of laboratory stopcocks recently introduced by the Emil Greiner Company, provides small, medium and large cover sizes ranging from 2 mm. to 15 mm. These Universal stopcock adapters are designed for laboratory technicians who require pressure stopcocks for burets, gas sampling, measuring apparatus, etc. They are manufactured of corrosion resistant materials, and are said to eliminate the annoyance of leaking stopcocks and the high cost of special pressure stopcocks. The small size comes in 2-4 mm.; the medium size in 6-8 mm.; and the large size in 10-15 mm.

Circle No. 30 on Postcard

Cooling Towers

A new bulletin by Aqua-Therm, Inc., describes the distinguishing feature of their cooling and scrubbing towers, a stoneware saddle fill which provides 50 square feet surface area for each cubic foot of volume.

Circle No. 31 on Postcard

Valve Lubrication

An article reprint by Minneapolis-Honeywell Regulator Company entitled, "Proper Valve Lubrication—A Prerequisite to Good Control," discusses the importance of proper valve lubrication in keeping valves operating at peak efficiency.

Circle No. 32 on Postcard

Industrial Plastic

Polydur—an unplasticized polyvinyl chloride, rigid, plastic—a product of Munray Products, Inc., is available in fabricated tanks, hoods, vents, ducts, etc. It is recommended for industrial equipment used under highly corrosive conditions. Polydur withstands temperatures up to 170° F. without dimensional deformation and does not lose chemical properties even at higher temperatures. Dielectric, self-extinguishing, and nonbrittle at sub-zero temperatures, it is lighter than aluminum.

Circle No. 33 on Postcard

Plastic Electrical Tape

Designed for applications where more-than-average mechanical strength is needed, the new heavy-duty plastic electrical tape designed by Minnesota Mining and Manufacturing Company has been designated "Scotch" brand electrical tape No. 21. It is recommended for anti-corrosion protection for pipes, cables and equipment laid underground where resistance to cuts and abrasion by rocks during back-fill is important. The tape has a black, vinyl plastic backing that is 20 mils thick, with dielectric strength of 22,500 volts, insulation resistance of 200,000 megohms, and an electrolytic corrosion factor of 1.0.

Circle No. 34 on Postcard

Water Level Alarm

A new Hi-Lo Water Alarm, based on the same established thermostatic principle as the Copes Feed Water Regulator, has been announced by Northern Equipment Division of the Continental Foundry & Machine Company and is described in a new bulletin. Designed for high-pressure service; it is adaptable for both stationary and marine boilers.

Circle No. 35 on Postcard

Temperature Bath

Precision Scientific Company has redesigned the "Frigistat" bath to provide frost-free, operation with a minimum of temperature control adjustments. Designed expressly for following ASTM method D97, the bath, although manually operated, can be maintained within ±2° F. The seven unit test chamber and the dry ice chamber are insulated with 2½ inches of glass wool at the sides and bottom. The cooling medium is circulated in the test chamber through coils which do not allow interchange of fluid between chambers. A full charge of dry ice plus the efficient one-quarter hp. pump will reduce temperature of the test chamber to —90° F. in about one-half hour.

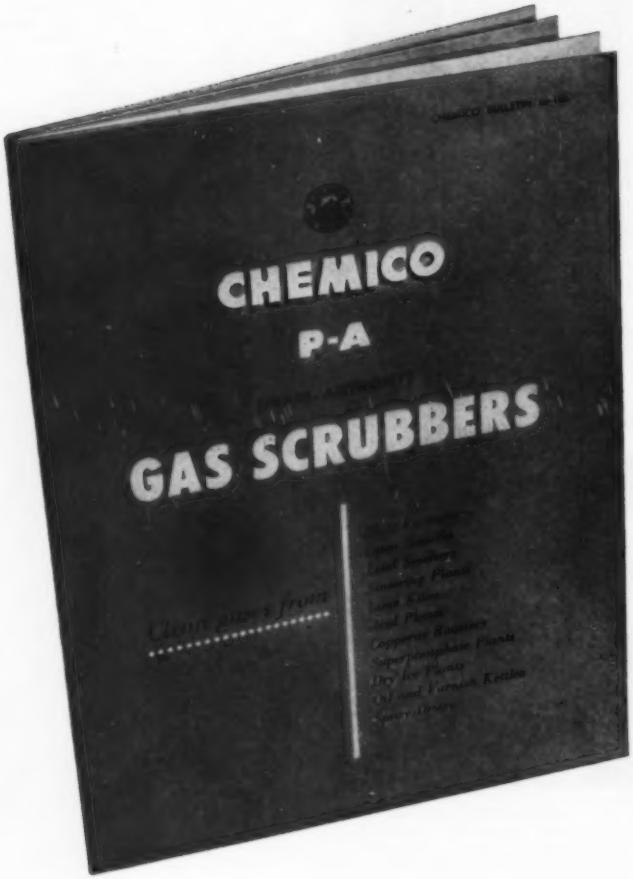
Circle No. 36 on Postcard

Control Center

A new motor control center for use wherever two or more a-c motors with up to 200 hp. and 600 volts are controlled from a central location, has been announced by General Electric. According to G-E engineers, the center provides a simplified method of centralized installing and servicing for a-c combination motor starters in NEMA sizes 1-5, as well as lighting panels and associated equipment for a group of motors.

Circle No. 37 on Postcard

High Gas Scrubbing Efficiency
AT LOW COST!



This Chemico bulletin contains factual information on the two types of Chemico P-A Gas Scrubbers. Both scrubbers offer high collection efficiency at low cost. Both are now being successfully used in a wide range of industries.

The bulletin gives performance data on the *P-A Venturi Scrubber* that effectively and economically removes sub-micron dusts, fumes and mists from industrial gases, and the *P-A Cyclonic Scrubber* for the removal of micron-size dusts from gas streams. If you have a gas scrubbing problem, write us detailing your specific requirements.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

CABLES: CHEMICONST, NEW YORK

TECHNICAL REPRESENTATIVE IN EUROPE—CYANAMID PRODUCTS LTD., LONDON

TECHNICAL REPRESENTATIVE IN SOUTHERN AFRICA—SOUTH AFRICA CYANAMID (PTY) LTD., JOHANNESBURG

Chemico plants are profitable investments

cc 229

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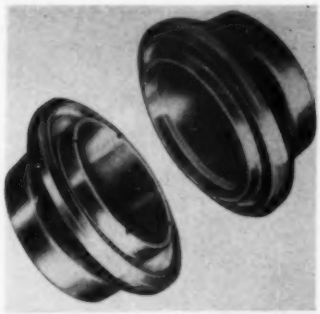
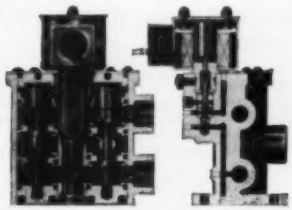
Welding Coupling



As seen in the photo, the Tube-Turn SF (scale-free) welding coupling manufactured by Tube Turns, Inc., consists of two forged halves designed to eliminate damaged welding scale in piping systems. The ends of the hubs are prepared for welding to pipe or welding fittings of corresponding sizes. When the halves are brought together, the tongue of one slips into the groove of the other and the circumferential cavity directly beneath the beveled welding area prevents burn-through or the formation of icicles in the interior. The cavity also insulates the interior from the extreme welding heat and so prevents scaling.

Circle No. 38 on Postcard

Four-Way Valve



Comprehensive data on Barksdale Valves' new Crescent valve line is contained in a bulletin edited for industrial use. Performance characteristics include continuous fast cycling of up to 600 cycles per minute without over-heating; production line valves which registered over 40 million cycles on test; size ranges of ¼, ⅜, ½, and ¾ inch, for single and dual pressure operation on air, water or light oil from 0 to 150 psi. Solenoids are available for all standard voltages AC and DC. Solenoids and pilot valve parts are the same for all sizes to simplify maintenance.

Circle No. 39 on Postcard

Coating Gun

Whether you call it "shot concrete . . . air placed concrete . . . pneumatically placed concrete . . . or gunned concrete" it can be done with the Bondactor, according to Air Placement Equipment Company, manufacturers of Bondact process equipment. The Bondactor Junior comes as a complete unit with a 60 cfm air compressor. Two of this model can be operated simultaneously with a 105 cfm compressor. In operation a siphoning action pulls the pre-mixed dry material from the hopper sleeve valve to the gun; air and water entering the gun through a common jet create this siphoning action so that perfect hydration is assured at all times. Where large volumes are required, the 1000-S model is recommended. This model can double its capacity to three cubic yards of premixed aggregate per hour. "The Bondactors" and "Use the Bondactor" describe the machine and use in detail.

Circle No. 40 on Postcard

Suction Line Strainer

Universal Valve Company has developed a 1½-inch suction line strainer, 611G, which will fit a 2-inch tank opening and is intended for use in pump suction lines. It is so designed that the liquid must enter from the sides instead of the bottom. In this treatment the water is not trapped and the line is kept free of foreign matter and sediment. On existing installations where volatile compounds have been used, the 611G will eliminate the danger of an explosion set off by sparks caused when chipping out existing bushing, according to Universal.

Circle No. 41 on Postcard

Electrical Equipment

A summary of all General Electric Company testing and measuring equipment for laboratory and production line use is contained is a new catalog, which is now available.

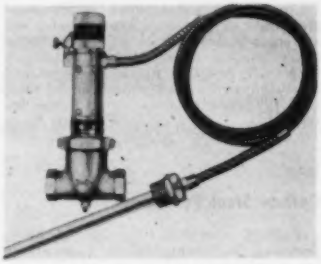
Circle No. 42 on Postcard

Materials Control

Remington Rand has offered a book detailing a unique method of materials control to shorten production time and increase production rates.

Circle No. 43 on Postcard

Temperature Regulator



Farris Stacon Corporation has added a new instrument to its line of self-operated temperature regulators which is known as Type UBA. The UBA is packless, single seated, fully balanced, and hermetically sealed for reliable operation under the most adverse conditions. A handy visual control is provided by a dial on top of the regulator. This instrument is available in ¼, ⅜ and ½-inch sizes for steam pressures to 150 psig, and control of temperature between 30° F. and 325° F. Control can be applied over a 60° F. range. Standard equipment includes eight feet of capillary tubing and a one inch NPT connection on the bulb.

Circle No. 44 on Postcard

Welding Electrodes

A new electrode-selector chart, listing the proper electrodes to be used in the welding of various metals, has been made available through General Electric Company. The new bulletin is designed to present condensed information on recommended electrodes for various welding jobs.

Circle No. 45 on Postcard

Coiled Aluminum Tube

Alcoa Utilitube has been registered by the Aluminum Company of America and is a general purpose aluminum coiled tube made of new Alcoa aluminum alloy B50S-O. It is said to combine low cost per foot, easy workability and high fatigue strength. A booket is available.

Circle No. 46 on Postcard

Tachometer

Herman H. Sticht Company, Inc., has improved its Jaquet Speed Indicator with a new ball bearing spindle, and new dial with extra scale divisions for greater readability. The new bulletin gives description, specification, and application.

Circle No. 47 on Postcard

To obtain additional data use free Reader Service Postcard opposite page 160. Circle number on card corresponding to number listed at the end of each item on which more data or literature is wanted.

Pyrex Heat Exchange Tubes

Charts and nomographs which simplify the calculation of heat transfer requirements are contained in Corning Glass Works' latest "Heat Exchanger Bulletin." Because pyrex glass resists corrosion, raw or sea water can be used with the glass heat exchange tubes described.

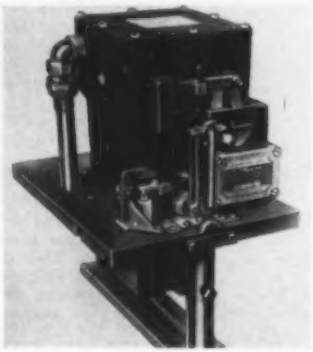
Circle No. 48 on Postcard

Carbon Steel Failures

Factors affecting tube life in high-pressure, high-temperature applications are featured in a new booklet by the Tubular Products Division of The Babcock & Wilcox Company. It investigates failures of carbon steel and other construction materials under certain temperature and pressure conditions.

Circle No. 49 on Postcard

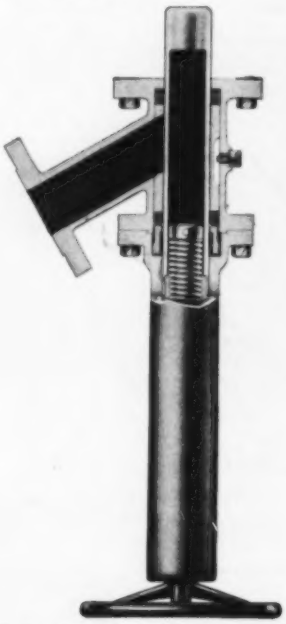
Viscosity Recorders



Viscometers for recording or recording-controlling of viscosity in industrial plants were recently designed by Norcross Corporation. This ("rugged") process instrument will measure, record, and where desirable, control the viscosity of solutions. The measuring element can be made of dimensions and materials suitable for the particular application, and extreme agitation of the solution will not disturb the operation of the instrument, according to the manufacturer. High and low viscosity alarms are readily adjusted to the maximum and minimum values of viscosity that can be tolerated for the process. A bulletin describing recording viscometers is available. The "M4" model pictured, is a measuring element which meets explosion-proof requirements.

Circle No. 50 on Postcard

Non-clogging Valve



Designed to prevent clogging, the Strahman Valves, Inc., Ram type drain valve in open position assures a full and unobstructed flow as the piston or ram is drawn down into the bonnet leaving a completely open passage for the material. In closed position the piston is forced up into the vessel pushing aside any matter that might tend to create clogging. There is no conventional gland; the piston moves through two resilient rings on which proper tension is maintained by compression nuts. Specifications are available.

Circle No. 51 on Postcard

Radiant Heaters

Keeping men warm and working in hard-to-heat locations both indoors and outdoors is being accomplished by Edwin L. Wiegand Company through its Chromalox electric radiant comfort heater, according to the manufacturer. The standard units are equipped with a six-inch length of BX cable and plug and two movable mounting clamps and bolts. It can be bolted on machines, mounted on portable rigs, or simply laid on the floor to warm worker's legs. The photo shows how three units were placed to maintain comfort at a boxcar shipping dock.

Circle No. 53 on Postcard

Heating Elements

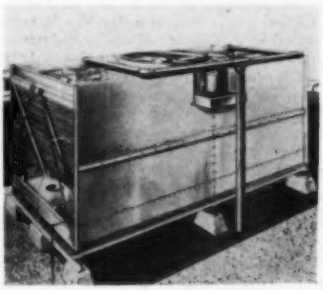
Film type heating elements are the subject of a new brochure published by the Electrofilm Corporation, covering uses, methods of application, and characteristics. These elements are made of electrically conductive plastic material.

Circle No. 54 on Postcard

Cooling Tower

The new Marley Company, Inc., Double-Flow Aquatower is a water cooling tower for use wherever intermediate capacities of cold water are required, says the manufacturer. It combines the efficiency of the Marley Double-Flow design with the compact simplicity of the well-known Aquatower. Pumping head and required fan hp. are low for any given capacity and design performance, and tower weight is evenly distributed over a wide area. A brochure is available.

Circle No. 52 on Postcard



DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

February ★ One of a Series of Interest to the Petroleum Industry ★ 1952

Automobile Manufacturers Make Use of DuPont Movie for Service Managers Clubs

Du Pont's movie, "What Makes A Gasoline Good?", was introduced in August 1950 as a means of helping oil companies teach service station personnel more about the basic product they sell. By the end of 1951, 188 prints were in circulation and in continuous demand.

When the film was shown recently to the national service managers of seven of Detroit's large automobile manufacturers, these men immediately recognized its value as an instruction and entertainment medium for their respective district service managers clubs.

It has been found also, that among automobile dealer service personnel, the film is an excellent medium for explaining how gasoline is made, how it is blended for seasonal variation, and what the differences are between regular and premium gasolines.

Oil companies benefit from such showings because automobile mechanics, armed with a better knowledge of the care and research which go into the blending of gasoline, are less likely to blame the fuel for shortcomings that are due to faulty timing, old spark plugs, or other types of mechanical maladjustment.

Has 25 Years Experience in Petroleum Chemicals Research

CHARLES J. PEDERSEN, now a research associate studying the mechanism of oxidation at Du Pont's Jackson Laboratory, was one of the early scientists in America to work on the commercial development of tetraethyl lead. Throughout his 25-year career, devoted almost exclusively to petroleum additive research, Mr. Pedersen has made many contributions to the petroleum industry. In addition to improvements in tetraethyl lead manufacturing, his 29 patents relate to such diverse fields as the development of gasoline antioxidants and metal deactivator. He is also responsible for inventions applying to lubricant additives and corrosion inhibitors for antifreeze solutions.

Mr. Pedersen, who is a member of the American Chemical Society and the American Association for the Advancement of Science, joined the Du Pont Company in 1927 after receiving his master's degree in chemistry from M.I.T.

From Swamp to Blending Plant! . . . Du Pont Helps Marketer Solve Unusual Problem

A large marketer needed a new tetraethyl lead blending plant. But two major obstacles stood in his way. The only site available for the building was a swampy lot near his bulk plant . . . and the area was highly congested with fuel storage tanks. The swamp presented an unusually difficult construction problem, the congestion a fire hazard.

COMPLETED AND READY FOR OPERATION, this modern blending plant was specially designed and built to the customer's particular needs. It is one of many such plants constructed with Du Pont help in the past 12 months.

To the marketer, it looked as if he were stymied so he came to Du Pont for help.

SPECIALLY DESIGNED

Du Pont is always prepared to furnish standard blending plant plans to any refiner or marketer. But this job called for a special design. Fortunately, tough problems like this are part of the daily routine for technical service representatives of the Du Pont Petroleum Chemicals Division and the whole project was planned in detail by Du Pont designers before construction began. Even recommendations for materials and equipment were included in the plans.

Because of the swamp, extra-strong piling was required to support the foundation. First, 19 ordinary wood piles were driven into the ground. These were then reinforced with iron bars and cement. The bars were laid across the top of the piles before the cement was poured into wooden forms built around the piles.

DU PONT REPRESENTATIVES Arthur C. Santora and Robert E. Holston discuss plans in detail with the superintendent of construction.

To overcome the congestion problem, Du Pont designers took measures to increase the fire resistance of the blend-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED

Blending Plant

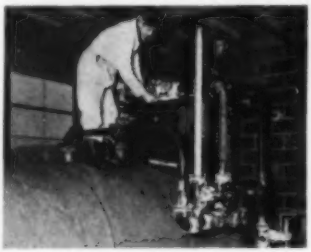
ing building. And throughout the construction, a Du Pont representative was on hand to advise the building crew. On such a job, his services include inspection and testing of equipment, as well as advisory help during the construction stages.

PERSONNEL TRAINING

In addition, as a final step, Du Pont representatives are prepared to train blending personnel in the safe and efficient operation of the unit. And for the customer's convenience, special equipment such as scales, weigh tanks, and pipe connections are obtainable through Du Pont.

SPECIAL PILING is required for construction in swampy land. It is made by pouring concrete over ordinary wood piles. The cement "caps" are also reinforced with iron bars.

THE BIG WEIGH TANK is eased onto cradle of scales by a crane. Because of the nearby fuel storage tanks, extra fire resistance is built into the cinder block walls.



A CAREFUL CHECK for leaks is made by Du Pont representative Robert Holeton. All valves and pipe connections are first soaped by the workman to make the check absolutely sure.

FINAL INSPECTION by Mr. Holeton helps assure that there is no foreign matter left in tank to clog valves. After this, the tank is permanently sealed for operation and no one is permitted to enter.

INTERIOR OF THE NEWLY COMPLETED blending plant. Extreme care is exercised to keep such plants immaculate since "good housekeeping" and safety go hand in hand in tetraethyl lead blending operations.

Fast, Reliable Tetraethyl Lead Deliveries Assured by Du Pont's "Warehouse-on-Wheels"

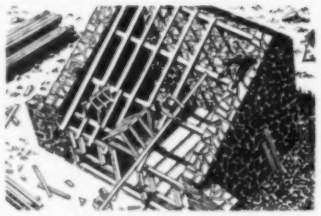
When you need an extra supply of TEL, or want a delivery faster than previously scheduled, there is a Du Pont TEL car, already loaded and strategically located at a rail siding ready for delivery to your plant.

For your convenience, and to meet emergency conditions, there are such Du Pont sidings in, or adjacent to, major refining areas. An ample supply of both Motor Mix and Aviation Mix is constantly maintained at these sidings. And there is someone at the phone to expedite your order at any time of the day or night.

Further, to meet the constantly growing customer demand, Du Pont recently expanded its TEL tank car fleet. All these "warehouse-on-wheels" facilities mean that you can receive Du Pont TEL *at your convenience*, rather than according to inflexible and sometimes inconvenient schedules.

Du Pont also maintains fully-stocked Petroleum Chemicals warehouses in Houston and Los Angeles, as well as in Wilmington. A month's supply of the complete line of Du Pont additives is always on hand at these strategically located shipping points.

Du Pont Historical Highlights



Powder mills such as those built by E. I. du Pont in 1802 had never been seen in America. The Du Pont mills were made of extra-heavy stone walls on three sides and flimsy framework on the fourth side and roof. Thus, if an explosion occurred, its chief force would be upward and away from other buildings—an important safety factor.

Such precautions, at the very outset, helped establish the pattern for a continuing safety program that soon placed Du Pont among the leaders in safety procedure.

Long experience in the handling of highly toxic chemicals put Du Pont in a position in 1923 to set up the only safe method for the manufacture of tetrathyl lead compounds.

Today, Du Pont not only maintains an outstanding safety record in its own plants, but also employs a staff of medical and safety advisors on call to help refiners guard the health and safety of their TEL blending personnel.

DU PONT
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. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • *Wilmington 98, Delaware*

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District Laboratories: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

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A-2983

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Catalogs AND EQUIPMENT *Literature* OFFERED IN THIS ISSUE'S ADVERTISEMENTS

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CEMENT, CONCRETE AND CASTABLE REFRACTORY GUNS—Catalog. Air Placement Equipment Co. See page 223.
Circle A1 on postcard.

TUBE CLEANERS—Information. Airetool Manufacturing Co. See page 176.
Circle A2 on postcard.

EXPLOSION-PROOF MOTORS—Bulletin 51B7286. Allis-Chalmers Mfg. Co. See page 7.
Circle A4 on postcard.

HEAT EXCHANGER TUBES—Booklet. Aluminum Company of America. See page 6.
Circle A6 on postcard.

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ANHYDROUS AMMONIA—Data. The Barrett Division. See page 72.
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PIPE AND BOLT MACHINE—Bulletin. Beaver Pipe Tools, Inc. See page 218.
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CONTROL VALVES—Catalog. Black, Sivalls & Bryson, Inc. See page 38.
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STEEL GRATINGS—Bulletin 2365. Blaw-Knox Co. See page 220.
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VERTICAL MULTI-STAGE PUMPING UNIT—Bulletin 51-6600. Byron Jackson Co. See page 81.
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TOWER ESCAPE DEVICE—Folder. Charlie's Machine Works. See page 223.
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MATERIAL HANDLING EQUIPMENT—Data. Dempster Brothers. See page 204.
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TUBE CLEANERS—Bulletin Y-29. Elliott Co. See page 145.
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FRACTIONATING TRAYS—Data. Koch Engineering Co. See page 50.
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COOLING FANS—Information. Koppers Co. See page 212.
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DIAPHRAGM VALVES—Bulletin 700-3. Minneapolis-Honeywell Regulator Co. See page 155.
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CHEMICAL CLEANING COMPOUNDS—Booklet F7629. Oakite Products, Inc. See page 219.
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PROCESS PUMPS—Bulletin B-1605. Peerless Pump Division. See page 9.
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AIR COOLED HEAT EXCHANGER—Bulletin 11.0.080. J. F. Pritchard & Co. See page 221.
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STEAM TRAPS—Information. Yarnall-Waring Co. See Second Cover.
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EXPANSION JOINTS—Catalog 47. Zallea Brothers. See page 79.
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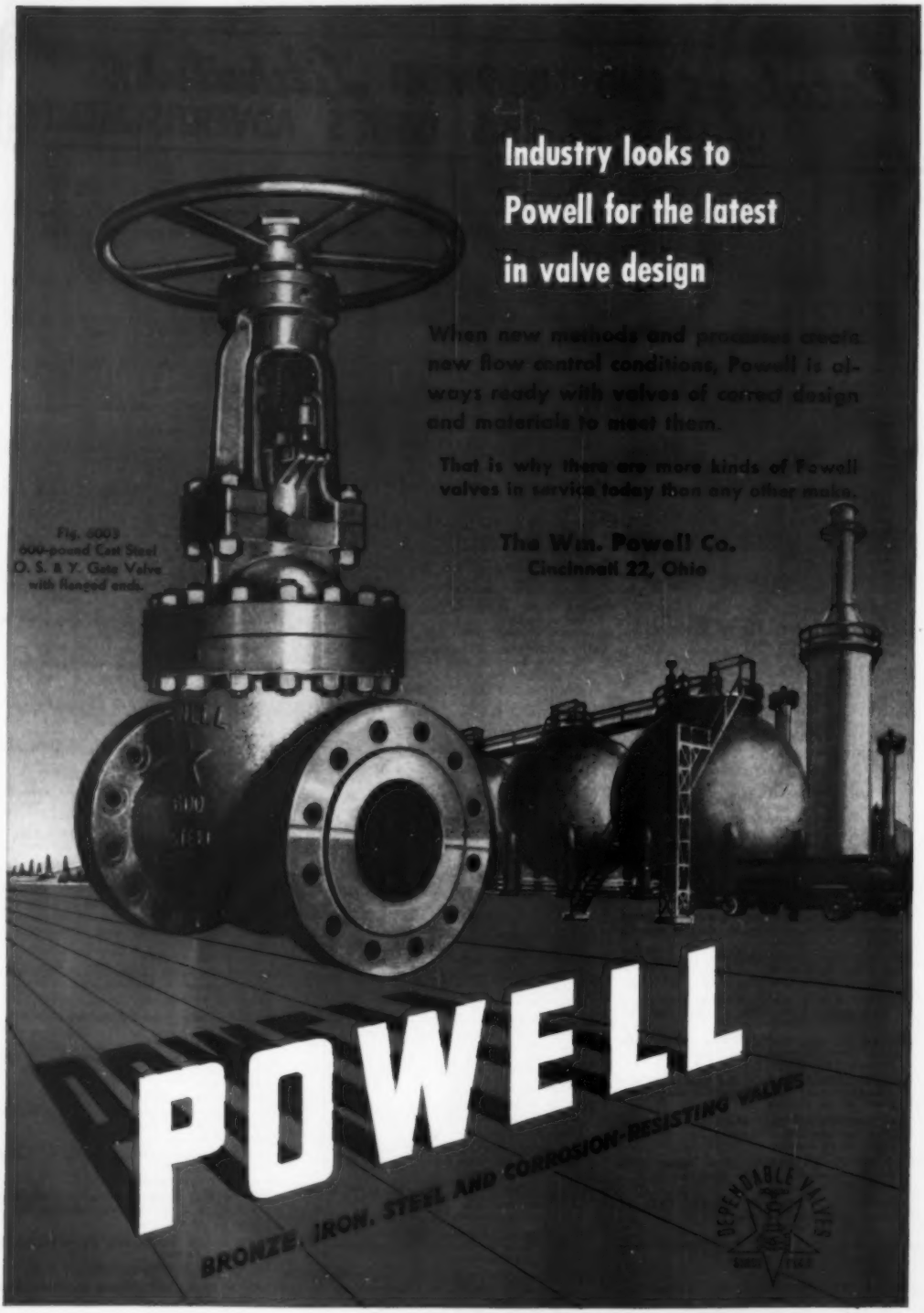
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POWELL
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DEPENDABLE VALVES

REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the processing industry.

Neppe Keeps Finger On Petroleum Pulse

Currently general manager of a large paper converting concern in Johannesburg, South Africa, S. L. Neppe, author of "The Chemistry and Rheology of Asphaltic Bitumen" on page 137, reports he is in constant touch with all developments in the oil world. To prove it he can produce a number of papers published in South Africa and England on "Transvaal Torbanite," "Cracking of Petroleum Oils," "Asphaltic Bitumens," "Sludge Gas," and "Producer Gas."

A lifelong native of Johannesburg, Neppe graduated in chemical engineering with a B.S. "degree with distinction" from the University of Witwatersrand in 1934, and won his M.S. degree in 1945 for a thesis entitled: "Contributions to Petroleum Cracking Technology."

After completing his schooling he served twelve years with the South African Torbanite Mining and Refining Company Limited as chief chemist, and obtained broad experience both at the oil refinery at Boksburg North, Transvaal, and at the torbanite retorting plant at Ermelo in the eastern Transvaal.

Into his 37 years, Neppe has managed to crowd in professional activity as a Fellow of the Royal Institute of Chemistry of Great Britain and Ireland, Associate Member of the Institution of Chemical Engineers, London, and membership in the Institute of Petroleum, England. In addition he has found time to satisfy his keen appetite for all sporting activities, particularly tennis, and also occasional contests of the less athletic games of chess and contract bridge. Married, Neppe has three daughters and a son.

Reports Gulf Expansion

The author of "Petrochemical-Refining Expansion on West Gulf Coast Unprecedented," on page 91, speaks from the bankers' viewpoint, for Harris McAshan has been president of the South Texas National Bank of Houston since March, 1948. Actually he has been associated with the bank since he graduated with honors from Princeton University in 1929, with the exception of two years spent as a national bank examiner and two years with a small San Antonio bank which later merged with the Alamo National Bank. For action with the wartime army he was awarded the Legion of Merit.

Van Winkle Again

Matthew Van Winkle whose last contribution to PR appeared in 1947 when he was an associate professor of chemical engineering at the University of Texas, returns to these pages this month as the author of "Equalibrium Constants of the Heavier Hydrocarbons at Subatmospheric Pressures," page 111. Now a full professor, Van Winkle's chief research interests are distillation (principally sub-atmospheric) and vapor-liquid equilibrium on the heavier hydrocarbons and petroleum oils at pressures below atmospheric. He is also working on vapor-liquid equilibrium of the oxidized hydrocarbons and methods of separation.

A Purdue University graduate of 1933, he joined the technical staff of Cities Service Oil Company at Okmulgee, Okla., where he remained until 1939. Following that he acted as a consultant to various petroleum companies and was with Standard Oil (Indiana) until 1941 when he joined the teaching staff at Pennsylvania State College as supervisor of extension work in petroleum and natural gas. Subsequently he joined the University of Michigan faculty in 1943 and was awarded the M.S. degree in 1945 while teaching there.

Van Winkle is the author of a book entitled "Aviation Gasoline Manufacture", and reports his main hobbies as tennis, fishing, photography and chess. Married, he and his wife have one son, one daughter, and one new Dodge.

Chemist Roams Sierras Seeking Game or Fish

Tramping the high Sierras with gun or rod in hand and his ten year old son darting along the route is a favorite way for Byron G. Adams to spend a few spare hours. Adams is the author of "Blending to Jet Fuel Specifications" which starts on page 95, but is also the author of many other articles which have been published in PR in times past.

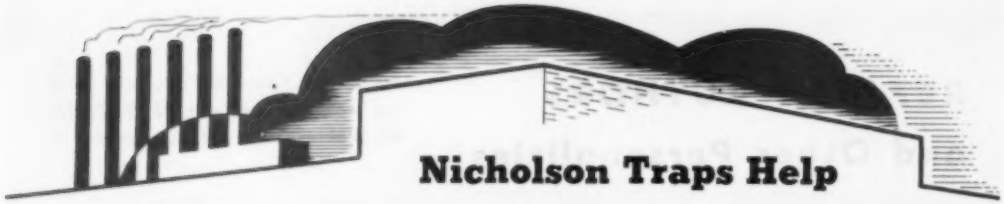
Chief chemist at the Bakersfield, Calif., refinery since 1936, surviving change of ownership from El Tejon Oil and Refining Corporation to the Douglas Oil Company of California in 1951, Baker's earlier experience included a post college era in the laboratory for Deep Rock Oil Company at Cushing, Okla., then later five years as laboratory technician for the Pure Oil Company near Port Arthur, Texas. Just prior to moving to Bakersfield he spent two years as lab technician with Associated Oil Company at Long Beach, Calif.

Adams says he spends "much" spare time with his wife, two sons, and three daughters, dividing the balance of his time hunting and fishing in the Sierras, or writing and working in his home workshop.

Is Product Engineer

Manager of product engineering in the Gasoline and Fuel Oil Department of Socony-Vacuum Oil Company, W. S. Mount is well qualified to present the article, "Engineering Developments Affecting Petroleum Fuels Volume and Quality," which begins on page 71. A mechanical engineering graduate of Lehigh University, he has devoted over 20 years to the petroleum aspects of automotive, aviation and Diesel engine fields. Active in SAE membership work, Diesel activity, and fuels and lubricants committees, he is also a member of the Institute of Aeronautical Sciences, the ASME, API, and ASTM. Author of

S. L. Neppe | M. Van Winkle | Byron G. Adams | Harris McAshan | W. S. Mount



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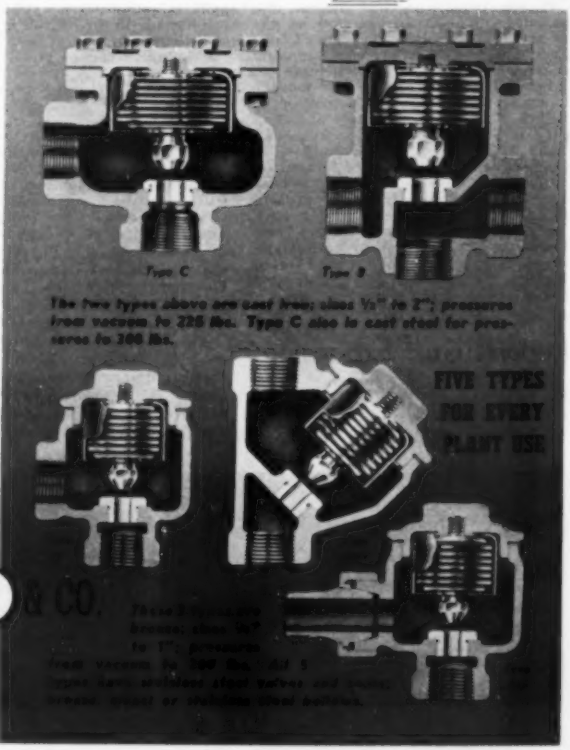
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numerous technical papers presented before the aforementioned societies, his responsibilities now encompass fuel oils, kerosine, solvents, liquefied petroleum gas, motor gasoline, Diesel fuels and aviation fuels.

Real Hobbies, These!

Phillips Divisions furnished the two authors of "Better Excess Flow Valves for Compressed Gases," found on page 107.

Of **Harry R. Ziegler** it is said that his green thumb is such that he could "charm roses into blooming right through a paved street if he put his mind, and his thumb, to it." Naturally, gardening is his great hobby in spite of "unusual" weather, and insects, of northeastern Oklahoma. A "Brooklyn boy," Zeigler is staff engineer in the Design Division of the Engineering Department at Bartlesville and is one of that hardy group of Phillips men who set out "to make natural gasoline behave itself" back in the mid-twenties. He joined Phillips in 1925 and is a graduate in civil engineering from Cooper Union, New York.

Doyle D. Buttolph, manager of the Instrument and Equipment Branch of the Chemical Engineering Division, has authored papers on LP-Gas Containers and LP-Gas Pumps. A native of Ames, Iowa, he graduated from the Iowa State College with a B.S. in mechanical engineering in 1940, just prior to joining Phillips as a sales engineer.

A captain in the Reserve, his hobby is collecting guns and developing marksmanship, reflects a four-year tour of duty with the Ordnance Department at Aberdeen Proving Ground, Md. He also enjoys "tinkering" and flower gardening.

He's Returned to City

Our Australian friend, George E. Mapstone, author of "Nomograph for Influence of Sulfur Compounds on TEL Efficiency" on page 132, has moved from his isolated station at Glen Davis to one of the northern suburbs of Sydney as principal research officer with the Commonwealth Scientific and Industrial Research Organization in the Coal Research Section.

Mapstone has been contributing to the magazine for many years and formerly was associated with National Oil Pty., Ltd., at its Glen Davis, New South Wales, location.

Laboratory Still Work Reviewed by Dow Trio

Three Dow Chemical men have grouped their knowledge concerning stills to produce "Laboratory Continuous Stills—Apparatus and Operation" on page 134.

L. E. Lloyd is a return visitor to this page as author of an earlier article on batch stills which appeared in February, 1950. If we speak "figuratively" about Lloyd it is with reason—for after struggling with Arabic figures as chief statistician in the treasurer's office during working hours, Lloyd spends a great deal of time "figure" skating during his leisure time. In fact, both Lloyd and his wife are figure-skating teachers. In addition, their own additions, six year old Vonnie and two year old Vivi-Anne, are up-and-coming skaters,[1] to the extent that the family is known as "the skating Lloyds."

A chemistry graduate of Manchester College, 1931, and a Sc.D. graduate in physical chemistry from the University of Michigan, 1937, Lloyd joined Dow the latter year and did research and development on ethylene purification and by-product recovery and utilization until 1942. Subsequently, he became a member of an engineering team charged with design responsibility for the Rubber Reserve styrene plants built by Dow. There followed a year of research, this time on new vinyl type monomers for plastics before he was appointed a staff member of the plastics' managers office in 1945. Since that time he has been appointed to the treasurer's office as chief statistician.

Allan C. Wilcox spent his boyhood days in Lansing, Mich., receiving his degree in mechanical engineering from Michigan State College. His pre-Dow experience included work with Babcock and Wilcox Company and short stints with the W.K. Kellogg and Gibson refrigerator companies, as well as three years as an AAF maintenance engineering officer. Joining Dow in 1946, he spent all his time at research and product development at Midland, with the majority of time devoted to distillation pilot plant work.

He reports he and his cute little western wife, Doris Eugenia from Pocatello, have agreed to disagree on everything from the virtue of monuntains versus lakes to rain versus desert. The two VIP's of the family are a son, aged four, and a two-year-old daughter.

Wilcox enthuses over gardening and landscaping their home, and rounds out his civic life as a Sunday School teacher, activity in the Boy Scout organization as neighborhood commissioner, and play-by-play support given to the "powerful" Spartan football eleven during the season. Other recreations include games of golf and bridge.

Midland born **K. E. Coulter** graduated in chemical engineering from the University of Michigan in 1941 and continued his Dow employment, which dated back through his school days to 1937, on full-time basis. During the ensuing years he has been engaged at both the Texas and Midland plants doing development and production work, a large portion of which was devoted to distillation research. To date he has authored or co-authored four published papers on distillation, plus an unpublished booklet on distillation for operating men. Coulter and his wife, Eleanor, have two daughters and a son.

His "outside" interests are hunting and farming, while his civic interests encompass such responsibilities as being director and secretary of the local school board, and representative of the township on the County School Board.

Starts New Series

Research engineer Peter W. Sherwood, a frequent contributor to PR, this month begins a new series entitled, "Shale Oil Production and Refining Today," on page 97. A Columbia University graduate, Sherwood has in the past been associated with Koppers Company, the Foreign Technical Mission on Fuels and Lubricants, which investigated German wartime industrial development, and for a period with Blaw-Knox Chemical Plants Division. He makes his home in Pittsburgh. Sherwood's previous series began in the August, 1951, issue and was entitled "Production of Ethylene from Petroleum Sources."

Cyanamid President Dies

Raymond C. Gaugler, president of American Cyanamid Company, died recently at his home in Larchmont, N. Y. Born in Pittsburgh, Pa., Gaugler was with the United States Aluminum Company in New Kensington, Pa., and the Northern Aluminum Company, Shawinigan Falls, Canada, and with Cyanamid since 1917. Gaugler has been a director of Cyanamid since 1929.

SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Fundamental Physical and Chemical Data

Isobaric Heat Capacity of Methane, EDWARD W. SLEDJESKI. *Ind. Eng. Chem.* **43** (1951), pp. 2913-15.

The author has used the Benedict-Webb-Rubin equation to calculate isobaric specific heat of methane over a range from 0 to 10,000 psi. pressure and from 100° to 1350° F. Values so obtained were found to be more accurate than those derived from simpler equations. The heat capacities derived from the experimental work of Budenholtzer, Sage, and Lacey over a relatively narrow range of variables were used as a basis for comparison in assessing the accuracy of the calculation. The methane isobaric heat capacity data presented are believed to be the best available over the extreme range of conditions covered. A bibliography of 10 references is included.

An Empirical Equation for Thermodynamic Properties of Light Hydrocarbons and Their Mixtures. Reduction of Equation to Charts For Prediction of Liquid-Vapor Equilibria. MANSON BENEDICT, GEORGE B. WEBB, LOUIS C. RUBIN, AND LEO FRIEND. *Chem. Eng. Progress,* **47** (1951), pp. 571-8.

This is the fifth of a series of papers on the thermodynamic properties of light hydrocarbons and their solutions. The purpose of the present paper is to show how the complex system of fugacity equations can be reduced empirically to a set of charts of fugacity coefficients and K-values that can be used to compute liquid-vapor equilibria in routine design problems without serious loss in accuracy. The procedure for using these charts is described, and an extensive comparison of reported determinations of liquid-vapor equilibria in mixtures of light hydrocarbons with equilibria predicted by the charts is given. A set of 324 charts has been prepared for the 12 hydrocarbons: methane, ethylene, ethane, propylene, propane, isobutane, isobutylene, n-butane, isopentane, n-pentane, n-hexane, and n-heptane at 26 pressures between 14.7 and 3600 psia. The charts cover a temperature range from —100° to +400° F. and a range of molal average boiling points from —225° to +180° F. In 12 mixtures of light hydrocarbons the average deviation of chart K from those evaluated by the fugacity equations is only 3.2 percent, which indicates that the charts adequately represent the fugacity equations in spite of the drastic reduction in the number of variables used to represent the effect of composition. It is concluded that the charts are sufficiently accurate for both engineering purposes. Examples of calculations are included.

P-V-T Relations of Gases: H. P. MEISSNER AND RALPH SEFERIAN. *Chem. Eng. Progress.* **47** (1951), pp. 579-84.

Experimental compressibility factors of gases may deviate from those predicted by standard compressibility charts. The magnitudes of these deviations correlate with z_c, the compressibility factor at the critical point for the gas in question. Deviations can be large for a gas having a value of z_c much different from 0.27. The authors present a graphical analysis of these deviations, and give a method whereby the compressibility factors read from a standard compressibility chart can be corrected. The correlation proposed predicts the correct compressibilities both in the perfect gas region and at the critical point. Most other relations fail in one or the other of these two conditions. A bibliography of 49 references is included.

Vapor-Liquid Equilibria at Subatmospheric Pressures. Dodecane-Octadecene System, B. T. JORDAN, JR. AND MATTHEW VAN WINKLE. *Ind. Eng. Chem.* **43** (1951), pp. 2908-12.

The authors studied vapor-liquid equilibria at subatmospheric pressures for a high boiling paraffinolefin binary system, namely n-dodecane-1-octadecene. The investigation is one in a series designed to determine the effect of subatmospheric pressures on vaporization characteristics of the higher boiling hydrocarbons. Vapor-liquid equilibrium data were obtained at 10, 20, 50, 100, 200, 400, and 760 mm. of mercury pressure. The activity coefficients of both compounds decreased with increasing pressure. They were less than unity at all pressures. The deviations of the activity coefficients from unity indicate that this binary system behaves in a non-ideal manner even at the low pressures. The variation, however, from ideal is not great. The data are presented in considerable detail in tabular and graphical form and a bibliography of 10 references is included.

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original article will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

Chemical Composition and Reactions

Isomerization of Saturated Hydrocarbons. IX. Isomerization of Ethylcyclopentane, 1,3-Dimethylcyclopentane and 1,1-Dimethylcyclopentane in the Presence of Aluminum Bromide. Synthesis of 1,1-Dimethylcyclopentane. HERMAN PINES, F. J. PAVLIK AND V. N. IPATIEFF. *Jour. Am. Chem. Soc.* **73** (1951), pp. 5738-40.

The relative ease of the isomerization of three isomeric cyclopentanes to methylcyclohexane was studied. These compounds were ethylcyclopentane, 1,3-dimethylcyclopentane and 1,1-dimethylcyclopentane. Under some conditions these hydrocarbons do not change to methylcyclohexane when subjected to aluminum bromide-hydrogen bromide unless traces of alkyl halides are added or when ultraviolet light is used. If small amounts of oxygen are present, aluminum bromide as such acts as an isomerizing catalyst. Benzene inhibits isomerization. Ethylcyclopentane isomerizes more easily than 1,3-dimethylcyclopentane, and the latter compound more readily than 1,1-dimethylcyclopentane. The authors feel that the results can be interpreted on the basis of the ionic chain mechanism.

The Behavior of Isobutane in Concentrated Sulfuric Acid, J. W. OTVOS, D. P. STEVENSON, C. D. WAGNER AND O. BEECK. *Jour. Am. Chem. Soc.* **73** (1951), pp. 5741-6.

The behavior of the butanes with sulfuric acid was studied by circulating each of the four monodeuterobutanes through the acid under varying conditons. The gaseous butane products were examined with the mass spectograph. The only reactions occurring at a significant rate in concentrated sulfuric acid are hydrogen-exchange reactions involving isobutane molecules. n-Butane does not react, and no isomerization of the change occurs with the other two isomers. The hydrogen-exchange reactions of isobutane are (1) the exchange of "primary" hydrogen atoms with the protons of the acid, and (2) an intermolecular exchange of "tertiary" hydrogen atoms among isobutane molecules. If isobutane molecules react at all they undergo both types of exchange. Chains are initiated by oxidation of isobutane by sulfuric acid to form ions (and sulfur dioxide) and chains are terminated by reaction of ions to form non-

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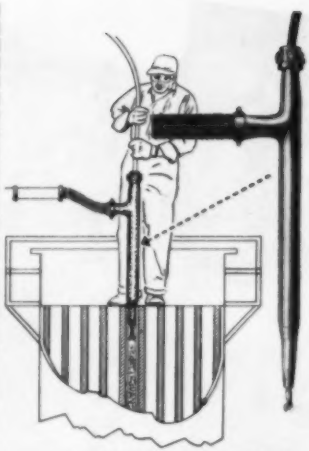

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The Critical Temperature and Critical Pressure of Nitrogen. DAVID WHITE, ABRAHAM SOLOMON FRIEDMAN AND H. L. JOHNSTON. *Jour. Am. Chem. Soc.* **73** (1951), pp. 5713-15.

Using an apparatus that was previously used in the determination of the critical constants of hydrogen and deuterium, the authors measured the critical constants of nitrogen by observation of the disappearance of the meniscus. The critical temperature was found to be 126.26± 0.04° K. and the critical pressure 33.54± 0.02° atmospheric. These results are compared with earlier vapor pressure data and with the critical constants estimated by extrapolation of P-V-T data.

The Adsorption of Normal Paraffins on Cracking Catalysts. ROBERT C. ZABOR AND PAUL H. EMMETT. *Jour. Am. Chem. Soc.* **73** (1951), pp. 5639-43.

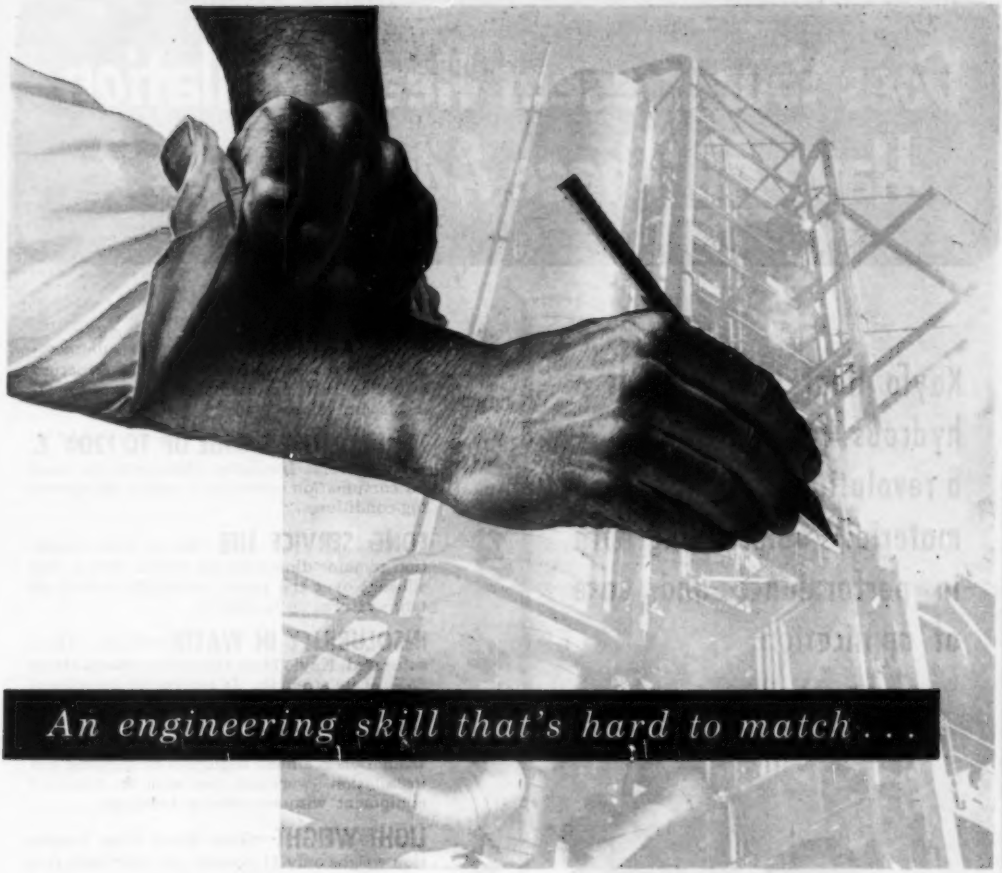
No data for the adsorption of paraffins on cracking catalysts have been published, and it has therefore been impossible to judge the extent to which carbonium ions or chemisorbed hydrocarbons are actually present on a catalyst during cracking. The authors accordingly made adsorption measurements with n-butane, n-heptane and n-octane on a Houdry S-46 cracking catalyst over the temperature range from room temperature up to and above the lowest temperature at which decomposition occurs. The adsorption was judged to be physical in nature up to about 150° C. Above this temperature, and even at cracking temperatures, the adsorption is very small, being equal to or less than 0.005 millimole per gram of catalyst.

Latent Heats of Vaporization of Some Organic Compounds. J. B. O'HARA AND R. W. FAHIEN. *Ind. Eng. Chem.* **43** (1951), pp. 2924-5.

The latent heats of many compounds are given only at the normal boiling point, and only for a few compounds have latent heat values covering an appreciable range of temperature or pressure been reported. The change becomes very large and approaches infinity when the critical point is approached because the latent heat drops to zero at the critical point. The authors present a tabulation of calculated latent heats of vaporization of 88 organic compounds from a pressure of 1 mm. to the critical pressure. In addition to the use of the latent heat values as such for the compounds reported, the results should also be of value in the use of reference substance-type plots for the prediction of latent heats of other compounds by comparison with the values given. A bibliography of 10 references is included.

Manufacture: Process and Plant

Heat Transfer Coefficients for Vapors Condensing on Horizontal Tubes, R. E.



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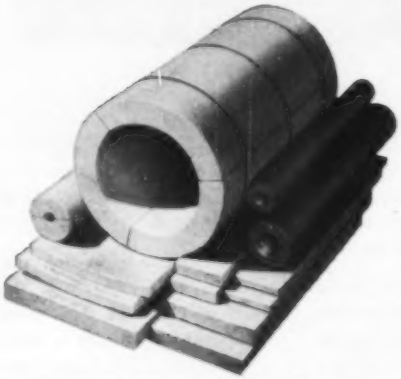

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PECK AND W. A. REDDIE. *Ind. Eng. Chem.* **43** (1951), pp. 2926-31.

The equation of Nusselt has been widely used to calculate film coefficients for a vapor condensing on a horizontal tube. However, experimental results have sometimes shown considerable deviation from the values so calculated. Two of the assumptions upon which the Nusselt equation is based are shown to be invalid. The authors present a correlation that is found to give more nearly correct results than the Nusselt equation. By application of the proper dimensionless group, as used in the correlation, it is possible to predict film coefficients with greater accuracy. A bibliography of 40 references is included.

Extractive Distillation. Design and Application, J. M. CHAMBERS. *Chem. Eng. Progress,* **47** (1951), pp. 555-65.

Extractive distillation is distillation in which the volatilities of the key components are altered by the addition of a third component. It is particularly useful in the separation and purification of chemicals produced synthetically and in the separation of other close boiling compounds. The author describes an extractive distillation column that has two sections, flowing countercurrent to the first key component in one section and cocurrent with the second key component in the other section. The volatility of the extracting component can be less than, greater than, or between the volatilities of the key components. It may form an azeotrope with one or both; the only practical restriction is that any azeotrope formed can be easily broken or is a desired product itself. Three examples of extractive distillation are presented and discussed.

Hypersorption Design. Modern Advancements, CLYDE BERG. *Chem. Eng. Progress,* **47** (1951), pp. 585-91.

The Hypersorption process is currently effecting separations of gas streams derived in petroleum refining, chemical manufacture, and natural gas operations. Recent advances in hypersorption design are outlined which have been incorporated in commercial units with capacities ranging up to 16 Mcf./day. As many as four well-fractionated products have been made from a single tower. The process employs a moving bed of activated carbon to absorb and fractionate components of a gas stream. Adsorption provides the unusual selectivity necessary for the recovery and separation of relatively volatile hydrocarbon gases as well as other components. Flow sheets of several Hypersorption units are presented with diagrams showing the temperature distribution in the towers. A bibliography of five references is included.

Symposium on Computing Machines in Chemical Engineering. *Ind. Eng. Chem.* **43** (1951), pp. 2441-83.

The Symposium comprises eleven articles dealing with the application of computing machines to the calculation of data and process design. The subjects covered are Evaluation of Equation of State Constants with Digital Computers, Calculation of Equilibrium Gas Compositions, Absorption Calculations by Punch Card Calculators, Selective Adsorption Computations with Digital

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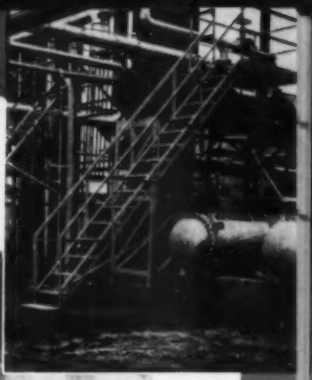

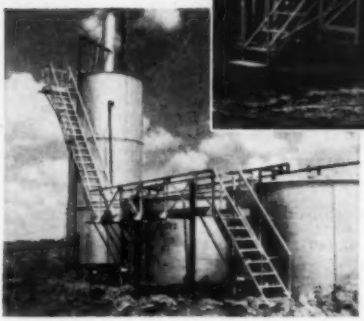

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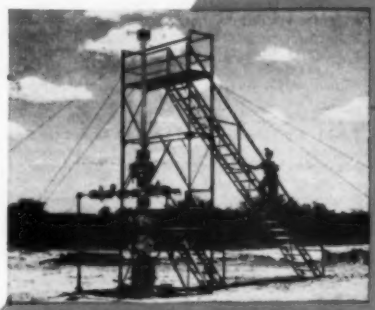

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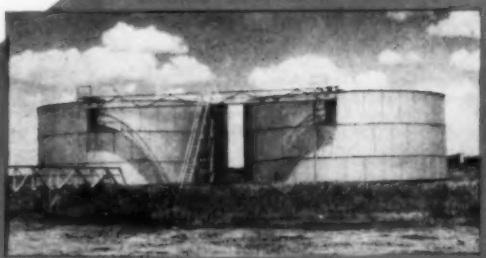

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Competitive and Co-operative Research in the American Petroleum Industry, ROBERT E. WILSON. *Jour. Inst. of Petroleum* **37** (1951), pp. 407-25.

This is the third Cadman Memorial Lecture before the Institute of Petroleum. The author discusses the organization and philosophy of research in America, and particularly the pros and cons of competitive versus cooperative research. In so doing he presents as an illustrative example a history of the development of cracking in the United States, starting with the developments of William Burton and extending down to the present time. The effect of patent and of cross-licensing on the development of the industry is considered. The research sponsored by the American Petroleum Institute and also government research, are briefly reviewed. The importance of encouraging basic research is discussed, as well as some threats to research work and the need for encouragement of research.

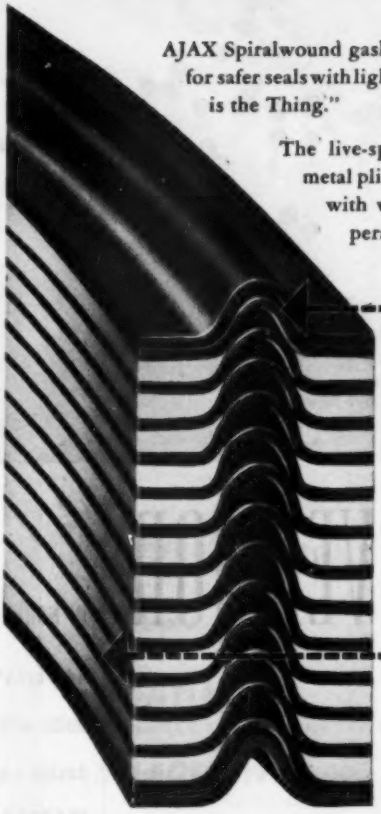
Digital Computers for Trial and Error Calculations of Distillation Design, ARTHUR ROSE, THEODORE J. WILLIAMS, AND HARRY A. KAHN. *Ind. Eng. Chem.* **43** (1951), pp. 2502-6.

The authors present a paper on the application of digital computers in trial and error calculations of distillation design. Such calculations are frequently necessary in the solution of a variety of engineering problems, and in many instances they involve extensive computation. The use of the IBM computers for performing automatically the trial and error calculations involved in the choice of a proper reflux ratio for continuous distillation is described. The same general procedure can be used for more complex distillation problems and for trial and error calculations of other unit operations.

Products: Properties, Utilization and Analysis

Knock Resistance of Pure Hydrocarbons. Correlation with Chemical Structure, H. K. LIVINGSTON. *Ind. Eng. Chem.* **43** (1951), pp. 2834-40.

This paper is one of those included in the Combustion Symposium. Although it is known that knock ratings correlate in a general way with certain hydrocarbon structures, such as the centralization of the hydrocarbon molecule, no detailed correlation between knock resistance and chemical structure has ever been presented. It is the purpose of the present paper to present such a correlation and explore its implications in terms of current theories of engine knock and hydrocarbon oxidation. A correlation based on current theories of engine knock and hydrocarbon oxidation has been obtained. The knock ratings predicted are consistent with the known research octane



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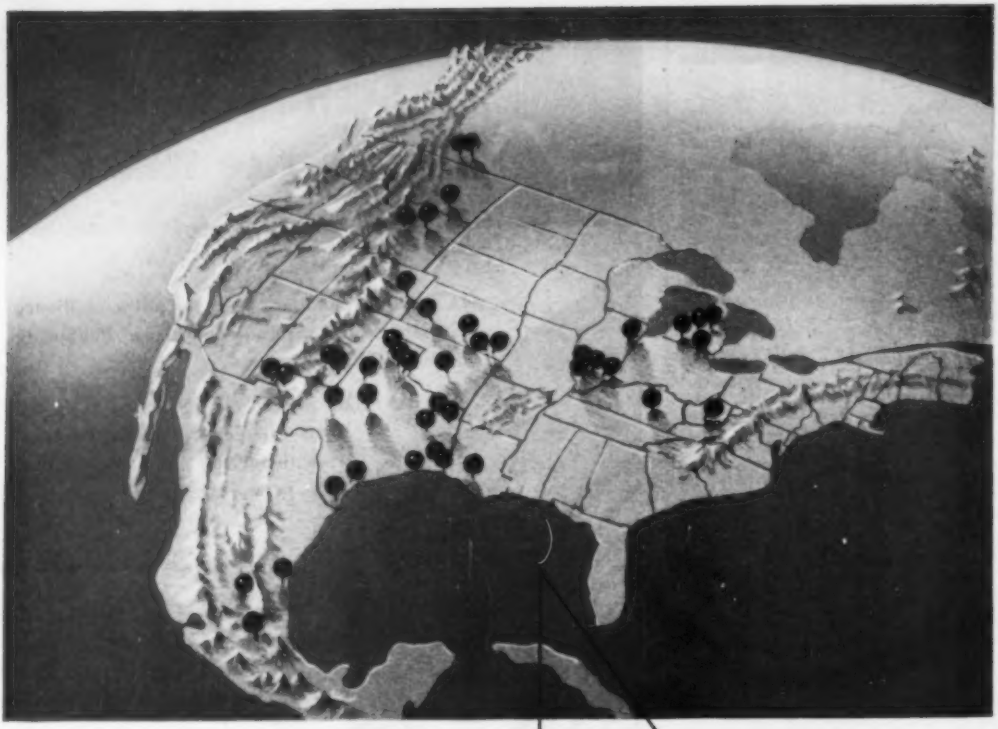

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ratings for almost all of the 108 pure hydrocarbons for which octane data are available. The resistance of hydrocarbons to knock is a function of structural factors that depend on electronic effects contributed by the following retarding groups: methyl, tertalkyl, vinyl, methylene (in ring compounds), and phenyl. The relative effects of these groups are summarized by eight rules that permit calculation of "structural retardation factors" for hydrocarbons from chemical structure alone. Success of the structural retardation factor method of predicting octane numbers emphasizes the importance of the initial oxidation reaction in the series of reactions that eventually lead to knock and provides a basis for further study of electronic and structural effects in hydrocarbon oxidation. A bibliography of 31 references is included.

Symposium on Combustion Chemistry. *Ind. Eng. Chem.* **43** (1951), pp. 2717-2869.

The Symposium on Combustion Chemistry comprises 28 papers presented before the Division of Petroleum Chemistry and Gas and Fuel Chemistry at the 119th Meeting of the American Chemical Society in Cleveland. Subjects covered are Flame Propagation, Flammability Limits of Hydrocarbon-Air Mixtures, Electrical Properties of Flames, Combustion in Bunsen Flames, Hydrocarbon Flame Spectra, Kinetics of Combustion, Preflame Combustion of Hydrocarbons, Fundamental Flame Velocities of Hydrocarbons, Burning Velocities, Vapor Phase Oxidation of Hexanes, Partial Combustion of Methane with Oxygen, Hydrocarbons in the Diesel Boiling Range, Initiation of Detonation in Gases, Autoignition by Rapid Compression, Two-Stage Autoignition of Some Hydrocarbons, Adiabatic Flame Temperature in Jet Motors, Carbon Formation in Gas Turbine Combustion Chambers, Tetraethyllead in Various Pure Hydrocarbons, Knock Resistance of Pure Hydrocarbons, Gasoline Combustion, Precombustion Reactions in an Engine, Diesel Engine Exhaust Products, Dual-Fuel Combustion in Diesel Engines, Lean Flammability Limit and Minimum Spark Ignition Energy, and Spontaneous Ignition Temperatures.

An Experimental Study of the Evaporation and Combustion of Falling Droplets, J. E. C. Topps. *Jour. Inst. of Petroleum.* **37** (1951), pp. 535-52.

The investigation was made to obtain a better understanding of the manner in which a fuel oil spray injected into a gas-turbine combustion chamber is burned. The evaporation of droplets of 300 to 500 μ diameter falling at their terminal velocity in high-temperature atmospheres was made. Pure hydrocarbons, and commercial distillate and residual fuels, were employed, both at atmospheric and at higher pressures.

Quantitative results on pure hydrocarbons, obtained by measurement of residues collected upon solid CO_2, showed a rate of evaporation approximately proportional to the radius.[6,8] It was concluded that in gas-turbine practice less advantage will be obtained from fine atomization than simple theory might lead one to expect. The difference between theory and actual result was accounted for mainly through the conduction of heat to the interior of the droplet, the rate being such that the heat available for evaporation is

reduced for the smaller droplets. Experimental difficulties at high pressure precluded quantitative treatment of the results. Qualitatively, however, it appeared that pressure had little effect upon the evaporation rate. Microphotographs of typical residues are included.

Mechanical Breakdown of Soap-Base Greases, R. J. Moore and A. M. Cravath. *Ind. Eng. Chem.* **43** (1951), pp. 2892-7.

The authors describe the mechanical breakdown of grease in terms of the disintegration of the fibers constituting the thickening agent as observed with the electron microscope. Since one of the important practical characteristics of a soap-base grease is its progressive softening upon prolonged mechanical agitation, it was desired to determine the cause of softening. It was found that breakage of the soap fibers occurred during softening by mechanical work. The ratio of length to diameter of the fibers was the factor having the largest influence on consistency. Breaking of the fibers appears to explain changes in consistency. The consistency was found to be a linear function of the logarithm of the time of working. The fluctuating stresses to which the particles are subjected under mechanical work occasionally reach unusually high values that exceed the breaking strengths of the particles. It is possible that this is the explanation of many cases of the mechanical degradation of small particles. Several interesting microphotographs are included and also a chart showing the length distribution curves of the fibers as mechanical work proceeds. A bibliography of nine references is included.

Determination of Carbon-Hydrogen Groups in High Molecular Weight Hydrocarbons By Near-Infrared Absorption. Albert Evans and R. R. Hibbard and A. S. Powell. *Analytical Chem.* **23** (1951), pp. 1604-10.

A previously reported method of determining CH_2, CH_3, and aromatic CH groups in hydrocarbons by near-infrared absorption spectroscopy was limited to compounds containing 18 carbon atoms or less. The present work was done to determine whether the method could be extended to higher molecular weight compounds. The near-infrared spectra (1.10 to 1.25 microns) of 24 hydrocarbons containing 13 to 34 carbon atoms and representing various types of hydrocarbons were determined. The absorption per functional group was found to remain nearly constant for compounds of the same type. The unit absorption coefficients calculated from the spectral data agreed closely with the coefficients determined previously with different groups of compounds. The agreement of absorption coefficients indicates that the average number of each of these three types of CH groups can be determined in samples containing any number of compounds of a single hydrocarbon type. Saturated fractions from five lubricating oils were analyzed. The results from the analysis of paraffin wax and polystyrene agree with the generally accepted structures for these products. No other method is known that will give similar analytical information.

Estimation of Sulfur in Petroleum Products. Electrical Device for Use in Determining Sulfur by the Lamp Method, C. W. Brown. *Analytical Chem.* **23** (1951), pp. 1659-62.

Time and samples have been wasted and consumed for many determinations of sulfur content by the lamp method because the minimum size of sample is fixed to accommodate the low-sulfur samples. For the same sized sample a high sulfur sample will produce a superfluous amount of sulfuric acid for subsequent titration. To minimize this difficulty a conductivity cell was constructed so that a unit meter reading was equivalent to a definite amount of sulfuric acid produced in the absorbing solution. It is also equivalent to one mg. of sulfur. The meter reading provides a convenient means for approximating the acidity of the solution. The procedure has proved satisfactory in routine use. It provides a control on the amount of sample to be burned, and allows for quick estimation of sulfur content, and gives an independent check on the conventional titration.

Determination of Nitrogen in Shale Oil and Petroleum. *Analytical Chem.* **23** (1951), pp. 1632-41.

This is a series of four articles on the determination of nitrogen in petroleum and shale oil. The first article deals with the application of established methods, including the Dumas and Kjeldahl. The second article deals with the effect of digestion temperature on nitrogen and determined by the Kjeldahl method. The third article reports an evaluation of the Dumas procedure, using the mass spectograph to analyze the gases in the ni-

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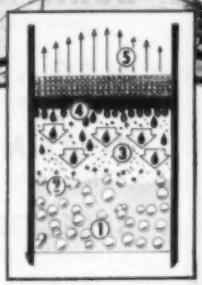

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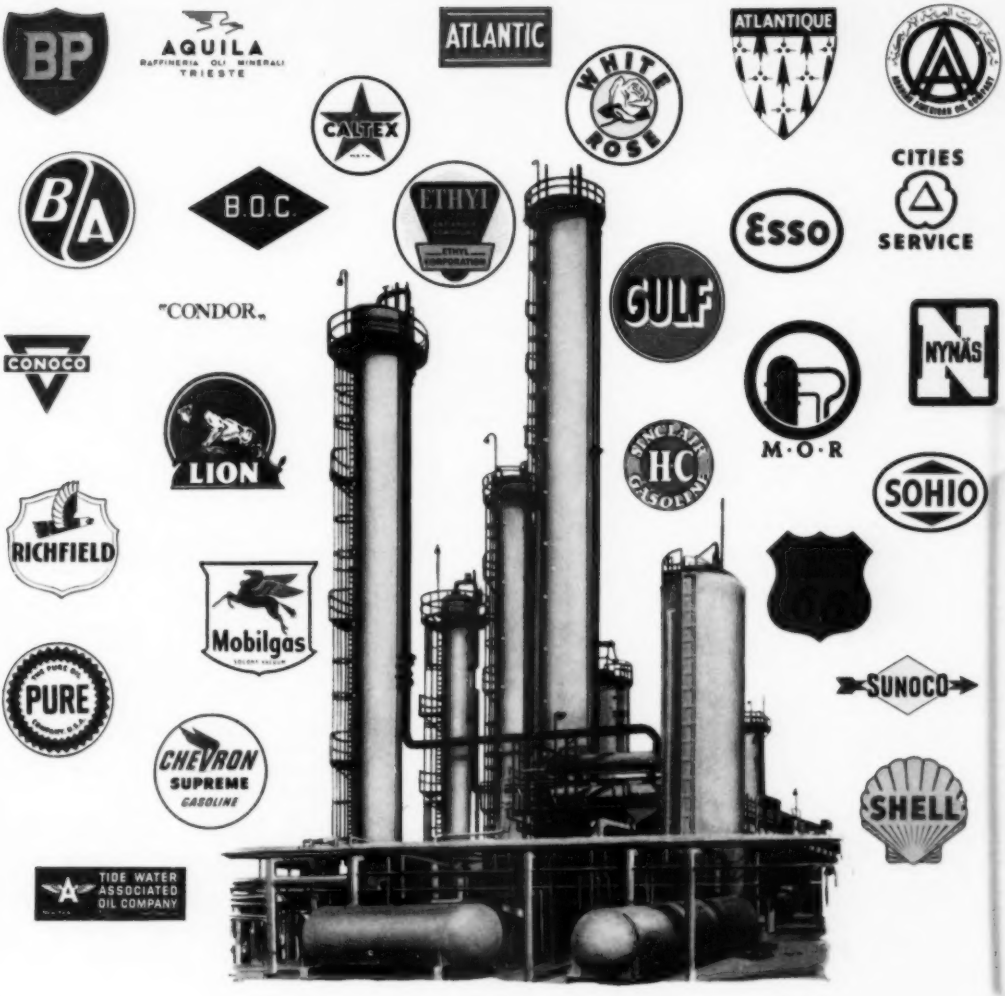

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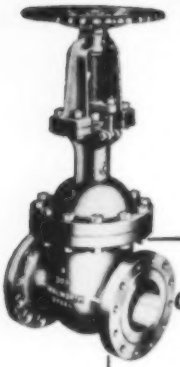

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trometer. The fourth article describes the determination of basic nitrogen by titration with perchloric acid.

Identification of Petroleum Products by Chromatographic Fluorescence Methods, JACOB A. SCHULDINER. *Analytical Chem.* **23** (1951), pp. 1676-80.

Chromatographic fluorescence methods were applied to the forensic problem of harbor and beach pollution with fuel and lubricating oil wastes. The source of crude petroleums can be identified similarly. Pollution by waste fuel, lubricating, and bilge oils is preventable. Each year this pollution causes damage to our inland fisheries, migratory water fowl, and beaches, and results in unsightly harbors and fire hazards to piers and shipping. The procedure was found useful in prosecuting harbor pollution violations in Baltimore harbor and in the upper Chesapeake Bay region. It resulted in many convictions and was responsible for periods during which pollutions ceased. The method can also be applied to the identification of the source of petroleum crudes. Various crude, semi-refined, and refined petroleum products give characteristic spot chromatograms by this method. It is also possible that other uses in the petroleum industry will be found for the rapid identification of products by similar methods.

Determination of Dry-Sludge Content of Fuel Oils: Development of the Shell Hot Filtration Test (SHFT), W. T. VAN KERKVOORT, M.B.E. and A.J.J. NIEUWSTAD. *Jour. Inst. of Petroleum.* **37** (1951), pp. 596-604.

The authors feel that existing methods for determining the dry-sludge content of fuel oils do not give reliable information. A new test has been developed in which the fuel is filtered, under pressure, through hardened filter paper using a specially designed apparatus. The method involves a minimum of adsorption and flocculation of oil components on the filter. After filtration, the filter and the residue on it are washed with a solvent and the filter disc is weighed. The procedure has been found to be useful in determining the actual dry-sludge content in all kinds of fuel oils, from gas oils to cracked residues. Used in conjunction with an accelerated storage test it provides a means of quickly obtaining quantitative information on the sludging tendency of a fuel blend. It also simplifies the analysis of tank bottoms and centrifuge deposits. A tabulation is presented showing a comparison of the results of the proposed method with other methods.

n-Heptane as a Standard Solvent For The Asphaltene Determination in Asphaltic Bitumen, E. EISMA AND C. J. KROM. *Jour. Inst. of Petroleum.* **37** (1951), pp. 582-7.

For the determination of the asphaltene content in asphaltic bitumens different countries prescribe different solvents, most of which are aromatic-free gasoline fractions. As a result, different values of the asphaltene content are obtained, for any given bitumens, and this fact gives rise to confusion. Different asphaltene contents may be found as a result of difference in chemical composition between gasoline fractions that conform to

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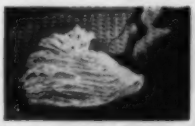

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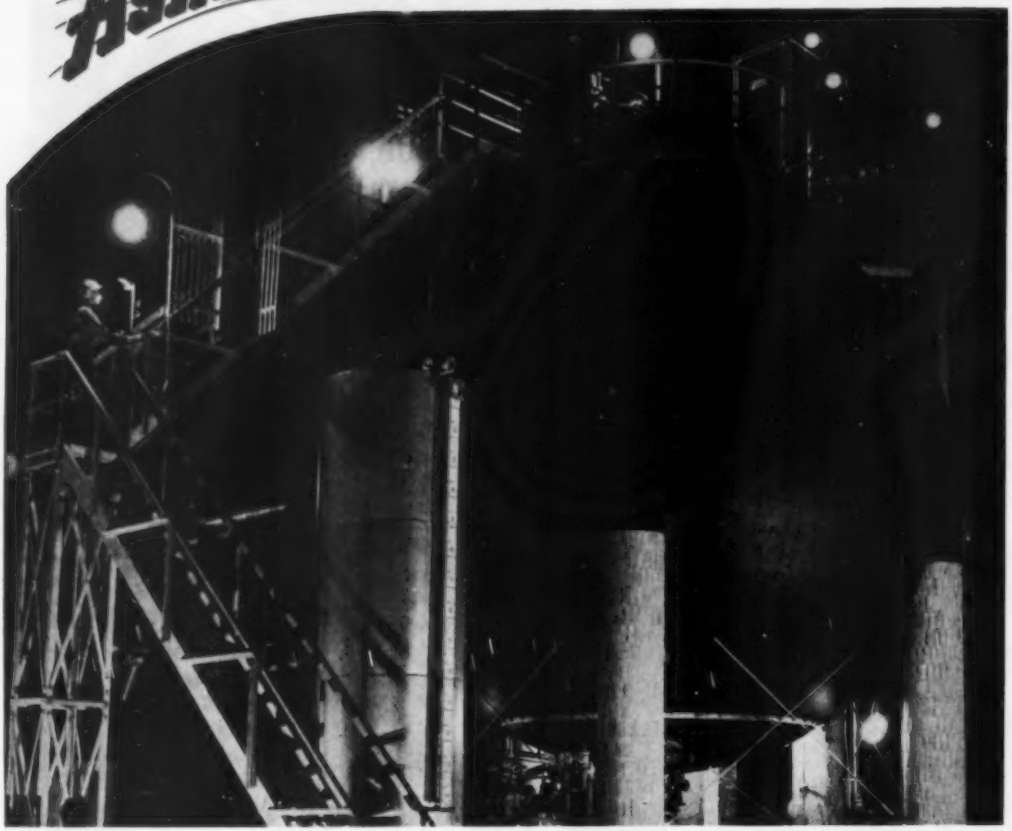

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specification limits. These drawbacks can be met by the universal use of one pure solvent. For this purpose normal heptane is suggested.

Insulating Oils: The Significance of the WIJS Iodine Value, C. N. THOMPSON. *Jour. Applied Chem.*, **1** (1951), pp. S40-8.

The present conception of the molecular composition of the hydrocarbons present in petroleum fractions in the insulating-oil range of molecular weights is given. Methods for determining the degree of unsaturation are discussed and in particular, the method of Wijs for determining the iodine value. The iodine value of a petroleum oil is not an absolute quantity, but an empirical number determined by a prescribed method. Its significance in relation to the other properties of electrical insulating oils is discussed, and its correlation with aromatic content as determined by chromatographic adsorption analysis is considered. When the iodine value of a normally-refined insulating oil of natural origin is determined by the method outlined, and multiplied by a factor between three and four, the product is found to be numerically equal to the aromatic content of the oil. The relationship between the gassing tendencies of insulating oils under electrical stress and their iodine values is demonstrated. The analytical details of the Wijs method of determining iodine values are discussed.

Spectrographic Analysis of New and Used Lubricating Oils, C. M. GAMBRILL, A. G. GASSMANN, AND W. R. O'NEILL. *Analytical Chem.* **23** (1951), pp. 1365-9.

The work was undertaken because of the need for accurate methods for determining the metal content of lubricating oils, in the control of blending of additive oils and for examining used oils. Ordinary chemical methods are too cumbersome and tedious and consequently, attempts have been made to use the speed of spectrographic methods. The authors describe such a method using a porous cup electrode technique for the determination of the additives barium, calcium, phosphorus, and zinc in new lubricating oils. An overall accuracy of ten percent is claimed. A second procedure uses a rotating disk electrode for the determination of lead, iron, and additives in used oils. The results of this method are compared with those obtained using porous cup electrodes. The accuracy is of the order of ten percent in the determination of lead and iron. The method is believed to be an addition to the tools in this field in that it applies to the analysis of both new and used oils.

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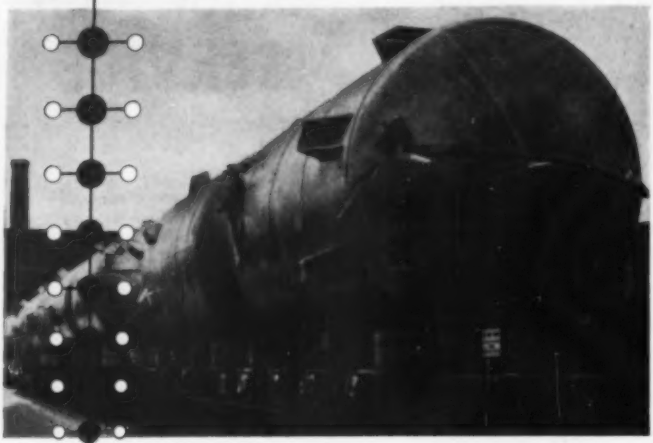

The use of aluminum equipment in the processing of fats, fatty acids and aldehydes shouldn't surprise you . . .

Aluminum has the advantage of not promoting oxidation of these sensitive compounds. The use of *all-aluminum* equipment from overhead condensers through to the storage and distribution of the finished product completely eliminates the problem of dissimilar metals which actually accelerate oxidation.

Aluminum does more. More than protect the taste, odor, stability and appearance of these products. It resists corrosion by free fatty acids in oils. It is non-sparking. Aluminum improves temperature control of your processes through its high heat conductivity. It is easy to clean. Easy to machine, weld and handle in the shop. In other words, aluminum fabricates easily. Over competing metals (other corrosion-resistant metals), you save ½ to 5/6 in material costs alone.

Alcoa's development engineers have much experience with vessels, storage tanks, filters, exchangers, pipe and tube of aluminum for fatty acid service. They offer their immediate personal attention to your questions. Write (company letterhead please) to:

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ing, California Institute of Technology; Herbert F. Kraemer, chemical engineering, University of Illinois; Philip Cockshutt, mechanical engineering, Massachusetts Institute of Technology; Russell W. Hall, Jr., physics, University of Oklahoma; James A. Amick, chemistry, Princeton University; Martha Havill, chemistry, Purdue University; George T. Fisher, entomology, Rutgers University; William A. Raatz, chemical engineering, University of Texas; J. A. Carlson, petroleum refinery engineering, University of Tulsa; Vincent J. Traynelis, chemistry, Wayne University; Gordon H. Millar, mechanical engineering, University of Wisconsin; William D. Tabachnik, mechanical engineering, Yale University.

Standard Indiana Promotes Public Relations Men

Positions as assistant directors of public relations were given Don Campbell, John Canning, and J. M. Patterson by Standard Oil Company (Indiana) recently. They will specialize in administration, communication through outside media, and projects and communications in company channels respectively.

Campbell has been copy chief since 1949 and prior to that was public relations assistant to the vice president of the American Locomotive Company for three years. A graduate of Kalamazoo College, Mich., he had earlier served as news editor of the Miami Herald and day news editor of the Detroit Free Press.

Canning, with Standard since 1935, was appointed press representative in 1945. Earlier he had served with the Associated Press, the Des Moines Register and Tribune, and other Iowa newspapers. He is a graduate of Grinnell College and received his M.S. from Northwestern University Medill School of Journalism.

Patterson joined the company in 1946 to coordinate activities in the 28 sales offices and five refineries. Previously he had been an executive of the Boy Scouts of America and assistant director of the Statistical and Research Service of the Scouts' National Council. He is a graduate of Birmingham-Southern College and holds an M.S. degree in psychology from Emory University.

On Argentina Assignment

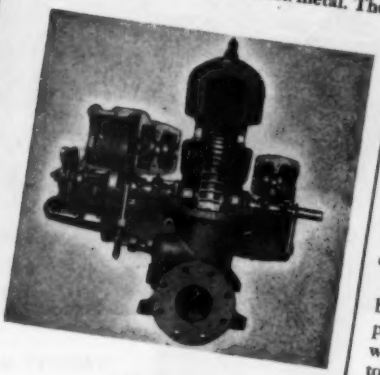
Assuming the duties of general superintendent of the Esso Petroleum refinery at Campana, Argentina, this month is Willard C. Clark, formerly assistant manager of employe relations. He relieves Carl Luikart, a one-time employe of the Baton Rouge refinery, whose retirement from the Campana plant is scheduled for next April 1. Mrs. Clark will join her husband in Campana in February, but the Clark children will remain in the U. S.

Join Houdry Research Unit

Harold Shalit, a Ph.D. from Polytechnic Institute of Brooklyn, and formerly associated with the Research Department of Standard Oil Company of Indiana, has joined the Research Division of Houdry Process Corporation. Another new member of Houdry's research staff is L. Edward Godycki, who recently received his Ph.D. from Iowa State.

TERRY

The rotor of a Terry Solid-wheel Turbine is a single forging of special composition steel. It is first rough turned in two operations, as illustrated, and then two cuts are taken to mill the semi-circular buckets from the solid metal. The wheel at the top has been finished, ready for mounting on the shaft. *The result is a single-piece wheel with no parts to loosen or work out.*



As the only function of the blades is to form a series of pockets, wear of the blades is of little consequence and does not materially affect the horsepower or efficiency. The important part of the bucket is the back, or bottom, which is a solid forging.

It is impossible for the blades to foul. They have large clearances, and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

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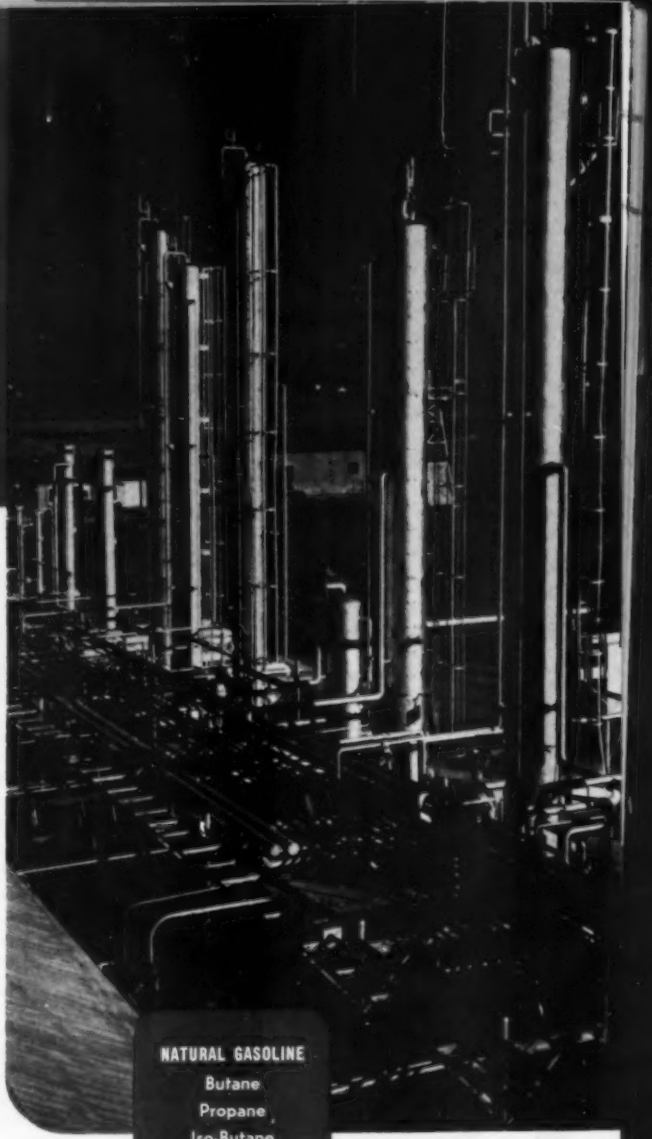
The recent action of the A.S.T.M. Committee D-2 (Petroleum Products) provides for an increase from 13.5 to 15 lbs. R.V.P. maximum vapor pressure for refineries marketing gasoline in the northern states. WARREN'S Natural Gasoline and Butane give greater volatility and higher octane rating; provide the necessary instant starting anti-knock, carbon-free elements which assure a balanced motor fuel.



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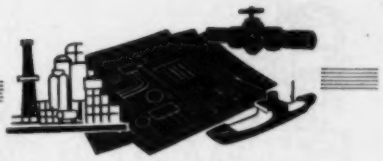
Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by DR. HEINZ HEINEMANN

(From the Official Gazette, November 13, 20, 27 and December 4, 11, 18, 25, 1951)



CATALYSTS PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,575,324. Nickel-Magnesia-Zirconium Silicate Catalyst. J. H. Shapleigh to Hercules Powder Company.

A catalyst for promoting the reaction between a hydrocarbon and steam comprises zirconium silicate, magnesia and 25-50 percent of nickel.

U.S.P. 2,575,457. Preparation of Phosphoric Acid Catalyst on a Precalcined Silica-Phosphoric Acid Base. J. M. Mavity to Universal Oil Products Company.

Solid catalysts useful in hydrocarbon conversions are prepared by mixing an oxygen acid of phosphorus with a siliceous adsorbent. The resulting composite is calcined and then impregnated with an oxygen acid of phosphorus. The resulting phosphoric acid coated composite is again calcined.

U.S.P. 2,576,653. Removal of Iron from a Cracking Catalyst. C. L. Thomas to Great Lakes Carbon Corporation.

A cracking catalyst with long catalytic life is produced by passing hydrocarbon vapors at cracking temperature over a lattice layer type body of clay or acid treated clay. The thus carbonized body is treated with chlorine gas or vaporizable chlorides of carbon at a temperature of 300-700° C. The remaining carbon is burnt off, whereupon the treated clay is acid treated.

U.S.P. 2,577,591. Preparation of a Supported Aluminum-Halide-Carbon Catalyst. H. R. Sailors to Phillips Petroleum Company.

A catalyst carrier is activated by depositing an aluminum halide-hydrocarbon complex on a solid inorganic adsorptive carrier, heating this carrier to a temperature below 900° F. to vaporize the aluminum halide and hydrocarbons and deposit carbon on the carrier, which is then treated with aluminum halide.

U.S.P. 2,577,631. Manufacture of Microspheriodal Gel Particles. W. A. Rex and K. J. Nelson to Standard Oil Development Company.

A hydrosol of an inorganic oxide is continuously withdrawn as a stream from a common hydrosol source and divided into two substreams. These substreams are treated in a special manner and supplied to a plurality of gelatin zones partially filled with an organic liquid setting medium. An inorganic oxide gel in the form of microspheroidal particles is obtained, e.g. of silica-alumina particles useful as a cracking catalyst.

U.S.P. Re. 23,438. Preparation of Silica-Alumina Cracking Catalyst. L. B. Ryland to Shell Development Company.

The claims of this patent are identical with those of the original patent No. 2,565,886 dated August 28, 1951.

U.S.P. 2,579,123. Reactivation of Silica-Alumina Catalysts by Silica Addition. W. A. Pardee to Gulf Research and Development Company.

A permanently deactivated silica-alumina cracking catalyst is impregnated at its surface with a fluid compound yielding silica upon decomposition, such as an alkyl silicate. By decomposition of this compound, the catalyst is reactivated.

U.S.P. 2,579,133. Reactivating a Silica-Alumina Catalyst by Impregnation with Boria. B. R. Warner and W. A. Pardee to Gulf Research and Development Company.

The method of this patent is closely related to that of U.S.P. 2,579,123. A fluid yielding boria upon decomposition is here employed as the material to bring about reactivation.

U.S.P. 2,579,678. Catalyst Regeneration. G. F. Kuhn to Sinclair Refining Company.

A finely divided hydrocarbon conversion catalyst is regenerated by suspending it in a current of air and conveying it thereby to an elevated chamber where it is separated from the air by gravity and passes to and downwardly through a regenerating chamber. Air withdrawn from the separating chamber is reintroduced at a lower zone of the regenerating chamber to pass upwardly through the downwardly flowing catalyst.

U.S.P. 2,579,834. Moving Catalyst Conversion System. R. Kollgaard to Houdry Process Corporation.

In the regeneration of granular hydrocarbon conversion catalyst, the catalyst is passed downwardly as separate laterally confined compact beds through vertically spaced consecutive combustion zones. More details are claimed.

U.S.P. 2,580,004. Removal of Iron from Regenerated Cracking Catalyst Fines. H. G. Corneil to Standard Oil Development Company.

In the regeneration of finely divided catalyst having particle diameters in the range of 0-200 microns in the presence of a hot combustion supporting gas at a temperatrue no greater than 1200° F., catalyst fines having a major portion comprising particle diameters in the range of 0-40 microns are contacted at a temperature of 400-700° F. with HF and then reintroduced with the HF into the regeneration zone.

NOTE

As of this month the PETROLEUM REFINER will present a more timely digest of patents by observing a later time deadline for Dr. Heinemann's material. This issue contains the digest of seven issues of the Gazette, a measure to cover the three week lag which had heretofore been in effect.

CRACKING AND REFORMING

U.S.P. 2,576,228. Autothermic Cracking Reactor. W. R. Kinnaird to Universal Oil Products Company.

The construction is claimed of a reactor for effecting the high temperature conversion of reactant streams, particularly for carrying out the oxidative or autothermic cracking of a gaseous hydrocarbon stream mixed with a controlled oxygen or air stream.

U.S.P. 2,579,576. Cracking with Acid-Treated Clay Catalyst. J. H. Hickey to Great Lakes Carbon Corporation.

Hydrocarbon oil is cracked in the presence of an activated bentonite clay catalyst. The clay is activated by reacting it at a temperature of 10-40° C. with 0.05-0.15 pounds of mineral acid of a concentration of 2-15 percent in water per pound of clay, and further reacting the clay, after separation from the treating solution, with an aqueous solution of a mineral acid of 5-15 percent concentration in an amount corresponding to 0.1-0.6 pounds of concentrated acid per pound of clay at a temperature of 80° C. to the b.p. of the solution.

U.S.P. 2,580,002. Process for the Production of Ethylene. E. W. Carrier to Standard Oil Development Company.

A light hydrocarbon gas containing C_2 to C_3 hydrocarbons is thermally cracked at a temperature of 650-850° C. under a pressure of at least two atmospheres. The pressure of the resulting

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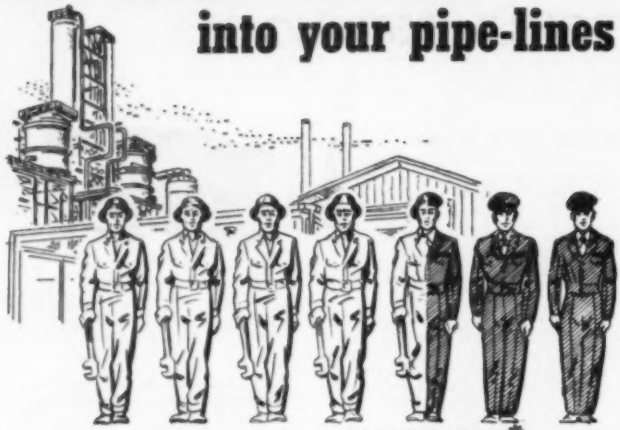

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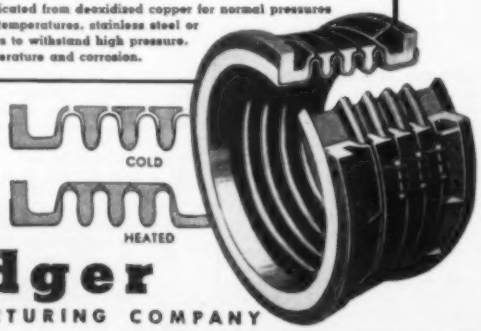

Badger
MANUFACTURING COMPANY
230 BENT STREET, CAMBRIDGE, MASS.

Patents

hot gas mixture is reduced to one atmosphere, and the hot mixture is then contacted with a hydrogenation catalyst containing an oxide of a 6th group metal in a soaking zone. An ethylene-rich fraction is separated from the resulting gas mixture.

REFINING

U.S.P. 2,575,341. Process for the Recovery of Butadiene from Cyclohexane Pyrolate. H. A. Gollmar to Koppers Company, Inc.

In the manufacture of butadiene by pyrolysis of cyclohexane, the butadiene is recovered by scrubbing the gaseous products of the pyrolysis with a low freezing mixture of cyclohexane and benzene, cooling and compressing the effluent gases from the scrubbing to recover cyclohexane and benzene therefrom, and recovering butadiene from the liquid effluent of the scrubbing.

U.S.P. 2,575,520. Adsorption Process. C. H. O. Berg to Union Oil Company of California.

Details are claimed of a continuous process for the separation of gaseous mixtures containing hydrogen and hydrocarbons with 4 C atoms or less into a plurality of fractions by selective adsorption on solid granulated adsorbents.

U.S.P. 2,576,071. Aviation or Motor Fuels. D. A. Howes, T. Tait, P. Docksey, S. F. Birch, and W. A. Partridge to Anglo-Iranian Oil Company, Ltd.

Details are claimed of a process for producing a blended high grade aviation or motor fuel from certain isohexane and isoheptane fraction and pure isoheptane together with tetra ethyl lead.

U.S.P. 2,576,525. Process for Separating Hydrocarbon Fractions Containing Aromatics. M. R. Lipkin to Sun Oil Company.

Of two hydrocarbon mixtures, each of which contains aromatic and saturated hydrocarbons and having a boiling range outside that of the other mixture, the higher boiling mixture is passed in liquid phase through silica gel to preferentially adsorb high boiling aromatic therefrom while displacing low boiling aromatic remaining thereat from the previous cycle. The lower boiling mixture is then passed in liquid phase through this gel to displace high boiling aromatic while adsorbing aromatic from the lower boiling mixture. Successive portions of the effluent during each cycle are further treated in order to finally obtain cuts, some of which are enriched in aromatics and some in saturates, and in higher and lower portions of each of them.

U.S.P. Re. 23,432. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are broken by means of a demulsifier including a hydrophile quaternary ammonium compound of a special type obtained by the reaction between a hydroxylated high molal amine of specific configuration and a certain type of ester. Details are claimed.

U.S.P. 2,577,202. Process for Separating Organic Compounds. A. P. Lien, W.

GULF'S NEW CAT CRACKER
demonstrates why refineries prefer Foxboro M-40 controllers

The ultra-modern fluid catalytic cracking unit at Gulf Oil Company's 28,000-barrel Cincinnati Refinery offers another example of the consistent performance that has won the petroleum industry's confidence in Foxboro M-40 Controllers. For this exacting new process, M-40 Controllers were selected because of their previous performance at Gulf . . . "an outstanding record of high accuracy, reliability, ease of maintenance and freedom from variation." In the 2 years since their installation at Cincinnati, they have continuously maintained this record!

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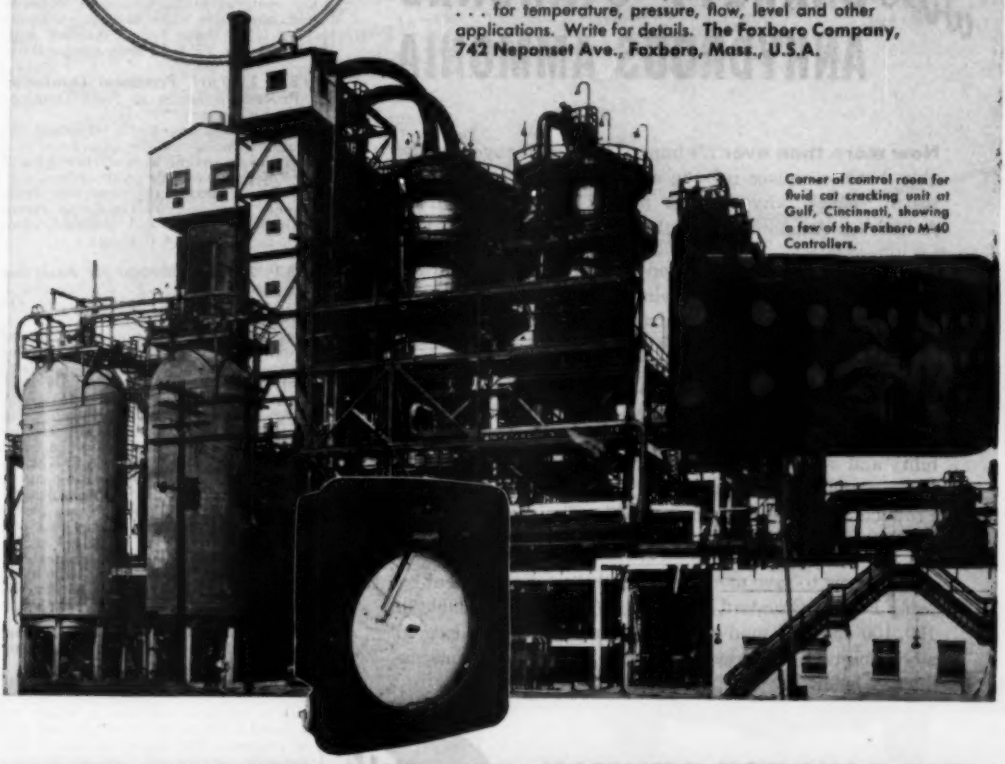

Corner of control room for fluid cat cracking unit at Gulf, Cincinnati, showing a few of the Foxboro M-40 Controllers.

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Patents

J. Zimmerschied and W. S. Higley to Standard Oil Company (Indiana).

A mixture containing urea-adduct-forming aliphatic organic compounds and a natural inhibitor for such formation, such as a West Texas virgin gas oil, is treated with a pretreated urea to produce such adducts. Urea is pretreated for this purpose by contacting it with water and an initiator for urea-adduct formation. This initiator consists of an aliphatic organic compound which has the property of forming a solid adduct with urea, such as straight-chain compounds containing at least 4-methylene groups or monomethyl-branched organic esters containing a corresponding straight-chain portion. On contacting the feed mixture with the pretreated urea under suitable conditions, a solid adduct of urea and the aliphatic compounds of the feed mixture is obtained.

U.S.P. 2,577,254. Removing Carbon and Carbonaceous Deposits from Heat Exchanger Equipment. S. D. Lawson to Phillips Petroleum Company.

Details are claimed of a process for the removal of carbonaceous deposits from the outer walls of heat exchange tubes which have been contacted with hydrocarbon fluids at high temperature.

U.S.P. 2,577,617. Fractional Distillation Process. J. Hudig to Shell Development Company.

Details are claimed of a fractional distillation process for the separation of a lower mole weight hydrocarbon from a slightly more volatile hydrocarbon, e.g., for the separation of propylene from ethane, in a mixture consisting essentially of saturated and olefinic hydrocarbons having 1-4 C atoms.

U.S.P. 2,577,640. Method for Analyzing Hydrocarbons. F. F. Wadley and J. A. Anderson, Jr., to Standard Oil Development Company.

A hydrocarbon fraction boiling in the gasoline or in the kerosine and gas-oil boiling range and containing dienes is analyzed by blending the fraction with a normally liquid saturated hydrocarbon. A first portion of the resulting blend is contacted with a treating agent selective for the removal of dienes, i.e. with HNO_3 or acidified $Hg(NO_3)_2$ or $KMnO_4$. After removal of this treating agent, separate beams of light at wave lengths of 235 and 258 millimicrons are passed separately through the treated first portion and through an untreated second portion of the blend. The values thus obtained give measures by which the diene index of the analyzed fraction may be obtained.

U.S.P. 2,577,701. Fractionation Process. P. H. Deming and M. L. Sagenkahn to Shell Development Company.

Ethylene is separated from its mixture with ethane by forming a vapor fraction rich in ethylene and poor in ethane and a liquid fraction rich in ethane and poor in ethylene. The vapor fraction is adiabatically compressed, and its temperature is raised above that of the liquid. By further treatment of portions of both fractions, with heat exchange between them, unliquefied substantially pure ethylene can be obtained. The method is useful also for the separation of mixtures of other components having close b.p.s.

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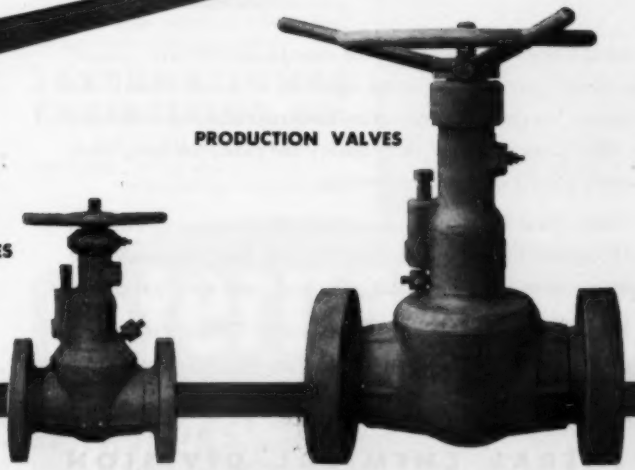

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Patents

U.S.P. 2,577,799. Recovery of Unsaturated Oil from Used HF Catalyst. J. P. O'Neil to Phillips Petroleum Company.

A heavy, unsaturated oil is produced from effluents of a process for reacting hydrocarbons in the presence of a liquid HF catalyst. Details are claimed of the process which is mainly concerned with the removal of the last traces of fluorine remaining in the heavy oil after separation of the HF present. This removal of fluorine traces is effected by contact of the oil with a bed of granular silica and the formation of SiF_4.

U.S.P. 2,578,054. Extractive Crystallization Process. L. C. Fetterly to Shell Development Company.

In the formation of crystalline molecular complexes between hydrocarbons and urea or thiourea employed as aqueous solution tending to increase its pH value to above 9.5, an amount of acidic material, such as acetic acid, is added sufficient to maintain the pH of the solution below 9.5.

U.S.P. 2,578,432-3. Process for Producing Apparent Solidification of Liquid Hydrocarbons. J. P. Labour to Gasoline Research Industrial and Commercial Company, Inc.

An aqueous emulsion of liquid hydrocarbons and methyl cellulose insoluble in water but alkali soluble (special "Tylose") is caused to assume a solid form by bringing it into association with H_2SO_4. According to U.S.P. 2,578,433, certain plant substances treated with an excess of alkali are employed instead of the "Tylose" substance. Certain metal sulfates may be employed instead of or together with H_2SO_4.

U.S.P. 2,578,510-2. Solvent Fractionation of Wax Containing Mixtures. E. W. Clarke to The Atlantic Refining Company.

A wax-containing mixture is contacted with an extraction solvent and solvent additives at a temperature such that two immiscible liquid phases are formed of which the one contains a higher melting wax fraction and the other contains a lower melting wax fraction, while both phases also contain solvent and additives. Solvent and additives are removed from both separated phases. The solvent employed comprises 1.6-2.4 volumes of nitrobenzene per volume of wax-containing mixture, the first additive comprises 0.25-0.35 volumes of anhydrous phenol, and the second additive comprises 0.25-0.35 volumes of aqueous phenol with 20-30 percent water per volume of wax-containing mixture.

According to U.S.P. 2,578,511, the solvent comprises 3.5-4.5 volumes of acetone and is introduced into the extraction zone near the point of withdrawal of the higher melting wax fraction, while the additive comprises 0.3-0.5 volumes of diethylene glycol and is introduced adjacent the point of introduction of the wax-containing mixture.

According to U.S.P. 2,578,512, the point of introduction of solvent and first additive are the same as in U.S.P. 2,578,511, while a second additive is introduced between the point of introduction of the first additive and that

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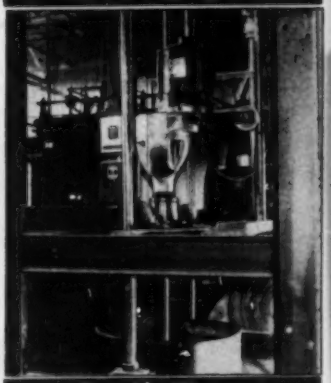

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of withdrawal of the lower melting wax fraction. The solvent here comprises 1.8-2.2 volumes of nitrobenzene and a small amount of BB'-dichloro-diethyl ether, and the first additive comprises 0.15-0.25 volumes of the same ether, and the second additive comprises 0.45-0.55 volumes of a paraffinic hydrocarbon with 8-18 C atoms.

U.S.P. 2,578,685. Method of Dewaxing Petroleum Products with Monobromo-Monochloro-Methane. K. A. Fischer.

Petroleum products are dewaxed by diluting them with monochloro-monobromo-methane, chilling the mixture, and separating the wax.

U.S.P. 2,579,692. Gasoline Fuel Containing Dimethyl Carbinol and Solvent Oil. J. E. Neudeck to Standard Oil Development Company.

A fuel composition consists of a mixture of hydrocarbons boiling in the gasoline range, 0.5 percent by volume of solvent oil, and 1.0-2.5 percent of dimethyl carbinol. The solvent oil consists of a liquid hydrocarbon mixture of certain physical characteristics.

U. S. P. 2,580,010. Process and Apparatus for Liquid-Liquid Extraction. M. R. Fenske and B. R. Tegge to Standard Oil Development Company.

Details are claimed of a process for extracting a liquid with a solvent incompletely miscible therewith.

U.S.P. 2,580,243. Process of Deleading Gasoline. E. B. Rifkin and D. H. Ewen to Ethyl Corporation.

Gasoline containing tetraethyllead is treated for deleading with an oxide of nitrogen, such as NO_2.

POLYMERIZATION AND CONVERSION

U.S.P. 2,576,515. Polymerization of Vinylcyclohexene. H. L. Johnson and A. P. Stuart to Sun Oil Company.

4-Vinylcyclohexene is contacted at a temperature of 35-130° C. with a catalyst consisting either of BF_3-ether complex, H_2SO_4, or $SnCl_4$. An oil-like polymer is formed having a molecular weight higher than the dimer.

U.S.P. 2,577,017. Preparation of Heavy Hydrocarbons of Hydrogen Isotopes. L. C. Kemp, Jr., to The Texas Company.

In the production of deuterocarbons, a stream of CO, prepared by reacting carbon with CO_2, is reacted with D_2O under water-gas shift reaction conditions. The mixture of free deuterium and CO obtained on removal of the CO_2 also formed in this reaction is subjected to hydrocarbon synthesis conditions in the presence of a synthesis catalyst.

U.S.P. 2,577,390. Polymerization Termination Agent. W. H. Watson to Polymer Corporation, Ltd.

In the emulsion polymerization of butadiene alone or in mixture with other, copolymerizable compounds, lignin is added to the reaction mixture

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during the polymerization in order to terminate this reaction.

U.S.P. 2,577,414. Transparent Casting from Styrene-Polyester Copolymer. G. L. Fraser and H. F. Park to Monsanto Chemical Company.

In the mass polymerization of 2-60 parts of styrene and 100 parts of a certain type of glycol-maleic acid unsaturated polyester in the presence of an organic peroxide catalyst, 0.01-1 percent of the sodium sulfonate of dodecyl benzene is incorporated in the reaction mixture prior to polymerization beyond the fluid state. A casting free from internal haze is obtained.

U.S.P. 2,577,432. Polyethylene Polyamine Activated Organic Peroxide Catalyzed Synthetic Rubber Emulsion Polymerizations. R. L. Provost to U. S. Rubber Company.

Butadiene-1,3 alone or in mixture with styrene or other $CH_2=C$ group containing compounds is emulsion polymerized in the presence of an organic peroxide catalyst, a polyethylene-polyamine activator, and 0.001-0.1 percent of alkali metal tartrate or citrate.

U.S.P. 2,577,677. Solution Polymerization. W. W. Crouch to Phillips Petroleum Company.

In the polymerization of a conjugated diolefin alone or in mixture with copolymerizable compounds in the presence of an alkali metal catalyst, the diolefin is dissolved in 40-100 parts of benzene or other liquid aromatic hydrocarbon and further treated with the addition of certain further amounts of such hydrocarbon. A solution of the polymer in the aromatic hydrocarbon is obtained.

U.S.P. 2,577,788. Concurrent Dealkylation of Aromatic Hydrocarbons and Dehydrogenation of Naphthenic Hydrocarbons. J. H. McAteer and C. E. Morrell to Standard Oil Development Company.

An alicyclic hydrocarbon is reacted with an alkylated aromatic hydrocarbon in the vapor phase at a temperature of 500-600° C. in the presence of an activated carbon catalyst using a liquid space rate of 0.1-10 V/V/Hr. Dehydrogenation of the alicyclic hydrocarbon and dealkylation of the aromatic hydrocarbon is effected simultaneously. The alicyclic hydrocarbon employed shall have at least five alicyclic C atoms and shall be more saturated than the aromatic hydrocarbon employed.

U.S.P. 2,577,791. Catalytic Contacting Unit with Gas Separator. D. D. McKinney to Houdry Process Corporation.

The construction is claimed of a gas-solid contacting apparatus wherein the heated solid contact material gravitating through a reaction housing is deflected in response to converging movement thereof along facing, downwardly inclined surfaces arranged, respectively, in diverging-converging relation as regards the vertical axis of the reaction housing.

U.S.P. 2,577,822. Cyclodiene Isobutylene Copolymers. W. J. Sparks and R. M. Thomas to Jasco, Inc.

A mixture of 0.5-50 parts of cyclopentadiene and 100 parts of isobutylene is cooled to a temperature of —20° to —164° C. A solution of an active Friedel-Crafts halide catalyst in an organic solvent is added. This solvent shall be liquid at the polymerization temperature and shall not form a complex with the catalyst. Methyl and ethyl chlorides are examples of such solvents.

U.S.P. 2,578,377. Catalytic Conversion of Hydrocarbons with Finely Divided Catalysts Utilizing Sonic Vibrations. R. B. Smith to Sinclair Refining Company.

In the vapor phase conversion of hydrocarbons containing a suspension of finely divided catalyst by passing this suspension and hydrocarbons in longitudinal direction through a vertically elongated reaction zone, the catalyst is simultaneously subjected to continuously generated sonic wave vibrations of the travelling wave type propagated in a direction perpendicular to said longitudinal direction.

U.S.P. 2,578,479. Process for Polymerizing Bis-Diphenylene Ethylene. E. J. S. Jennings and A. F. Williams to C. D. Patents Ltd., London.

Bis-diphenylene-ethylene is heated with benzoyl peroxide as a catalyst to a temperature of about 360° C. Thermo-

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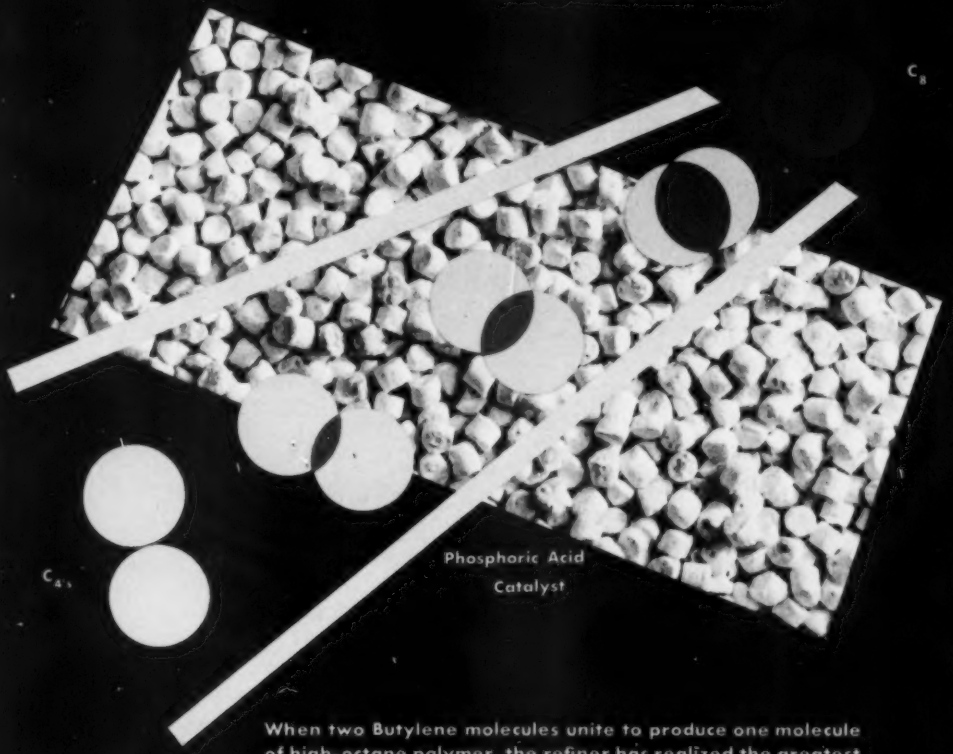
catalytic polymerization



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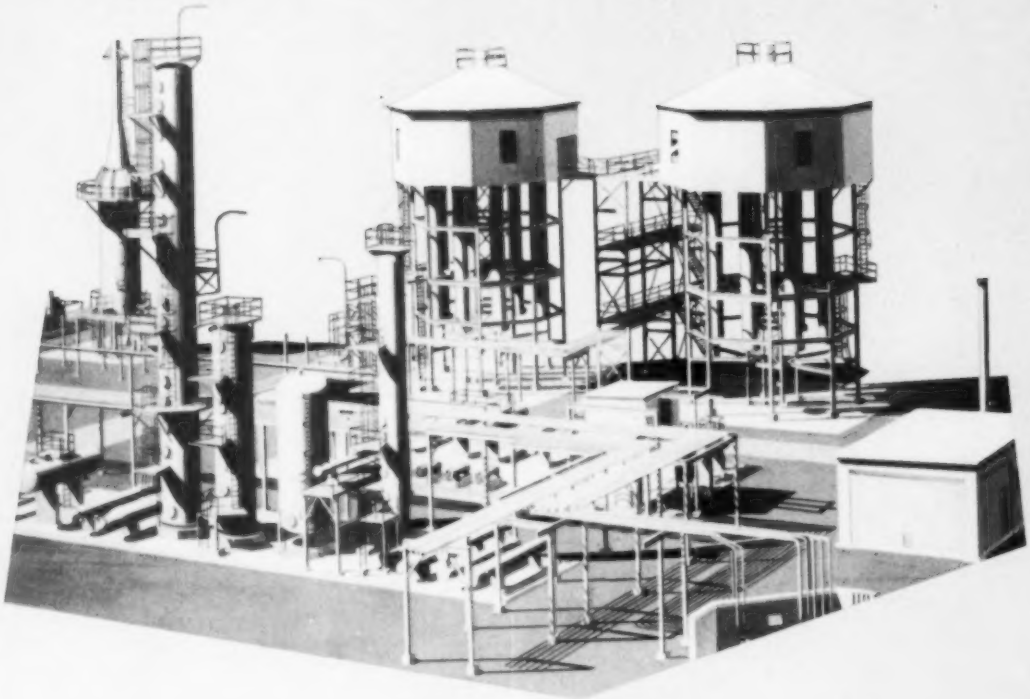

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plastic resins of a melting point above 450° C. are obtained.

U.S.P. 2,579,106. Method of Preparing Cyclooctatetraene. C. E. Barnes to General Aniline and Film Corporation.

In the preparation of cyclooctatetraene by condensing acetylene at elevated temperature and pressure in the presence of a nickel compound catalyst, in a solvent containing tetrahydrofurane, 0.05-1 percent of an antioxidant is incorporated in the solvent, so as to avoid the presence of tetrahydrofurane peroxide during the reaction.

U.S.P. 2,579,398. Method for Handling Fuels. B. E. Roetheli to Standard Oil Development Company.

A stream of finely divided carbonaceous solid material, such as oil shales, peat, tar, or coal, is passed through a circuit comprising a carbonization, a gasification, and a combustion zone. The material under treatment is maintained as a fluidized mass in these zones. The temperature in the carbonization and gasification zones is controlled by recycling solid residue highly heated in the combustion zone to the gasification zone and returning solid gasification residue to the carbonization zone. Valuable volatile fuels are recovered.

U.S.P. 2,579,433. Process for Polymerizing Olefins. M. M. Holm and G. E. Langlois to California Research Corporation.

An olefin-containing material is contacted with a catalyst consisting of nonporous, inert, solid particles having an average diameter not greater than that of 28-35 mesh particles and having a thin film of concentrated phosphoric acid disposed thereon. Polymerization of the olefins is effected.

U.S.P. 2,579,442. Polymerization of Ethylenically Unsaturated Compounds with Cyanuric Triazide Catalyst. H. F. Park and H. A. Walter to Monsanto Chemical Company.

An ethylenically unsaturated polymerizable monomer, such as styrene, is mass polymerized in contact with cyanuric triazide catalyst at elevated temperature.

U.S.P. 2,579,672. Catalyst Chamber. W. L. Houston, Jr., to Phillips Petroleum Company.

The construction is claimed of an apparatus for effecting hydrocarbon conversions in the presence of a solid catalyst. The reactivation of the catalyst is effected in situ.

U.S.P. 2,579,908. Aqueous Emulsion Polymerization with Low Initial Soap Concentration. J. A. Davidson and W. R. Dunn to U. S. Rubber Company.

Details are claimed for the emulsion polymerization of styrenes, butadienes-1,3 and other unsaturated compounds in the presence of volatile base soap and up to 10 percent of certain acrylic compounds.

U.S.P. 2,580,315. Emulsion Polymerization Process. H. F. Park to Monsanto Chemical Company.

Styrene is emulsion polymerized in

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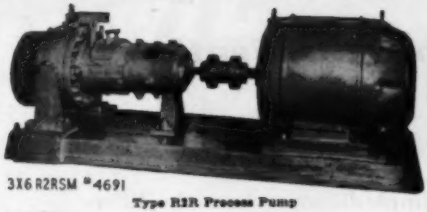
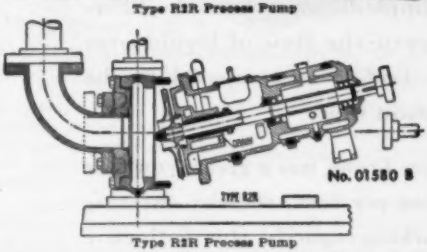


Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

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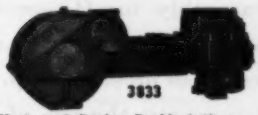
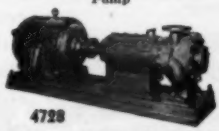


Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



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Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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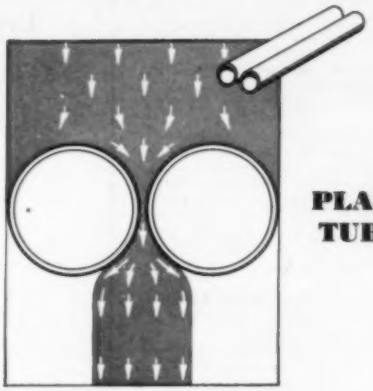

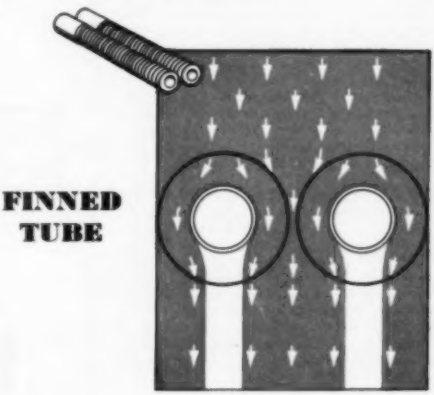

This illustration shows the results found in our laboratory tests. A plain tube, ¾″ O.D. and Trufin having ⅝″ root diameter were used in the tests (the outside diameter of the fins is comparable to that of the ¾″ plain tube). The center distance between the plain tube and the finned tube conformed to the code requirements of a minimum 15/16″ spacing. Both oil and water were used in the tests.

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the presence, as emulsifier, of a small amount of a primary alkyl amine ester the alkyl group of which contains 8-22 C atoms. The ester group is a radical of a lower aliphatic acid with 1-5 C atoms. A water-soluble catalyst is employed.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,576,034. Catalytic Dehydrogenation of Paraffins. J. W. Myers to Phillips Petroleum Company.

A paraffin hydrocarbon diluted with 1-30 volumes of steam is contacted at a temperature of 1000-1400° F. with a catalyst consisting of 10-45 percent by weight of alumina and 90-55 percent of at least one of the oxides of Mo, W, or V. Dehydrogenation is effected.

U.S.P. 2,576,743. Preparation of 4-Ethylcyclohexene. O. C. W. Allenby to Canadian Industries, Ltd.

4-Vinylcyclohexene is reacted with hydrogen in the presence of a nickel catalyst and methanol or ethanol at a temperature of 10-20° C. until slightly more than one molecule of hydrogen has been absorbed for each molecule of the charge material. 4-Ethylcyclohexene is obtained.

U.S.P. 2,576,858. Synthesis of Organic Compounds. L. C. Rubin to The M. W. Kellogg Company.

In a Fischer-Tropsch synthesis, a mixture of a carbon oxide and hydrogen is passed through a mass of finely divided contact material comprising a mixture of catalyst particles of varying size. A substantial portion of these particles shall have free settling rates less than the superficial velocity of the passing gases. The velocity of the passing gases shall be such that a lower relatively dense pseudo-liquid phase and an upper relatively dilute phase of cantact material is formed with an interface therebetween, and that a substantial proportion of this material is entrained in the dilute phase. A liquid substantially free from solids and completely vaporizable at the reaction conditions, e.g. water or a hydrocarbon, is injected into the dilute phase above the interface for minizing entrainment of contact material in the dilute phase and suppressing the formation of methane.

U.S.P. 2,576,931. Synthesis of Hydrocarbons in the Presence of a Fluid Phase Catalyst. P. W. Garbo to Hydrocarbon Research, Inc.

In the Fischer-Tropsch synthesis making use of fluidized catalyst particles, highly active catalyst particles are continuously withdrawn from the bottom portion of the fluidized mass and continuously reintroduced into the reaction zone in the vicinity of the upper surface of the mass.

U.S.P. Re. 23,433. Recovery of Oxygenated Compounds and Hydrocarbons from Mixtures Thereof. R. F. Marschner to Standard Oil Company (Indiana).

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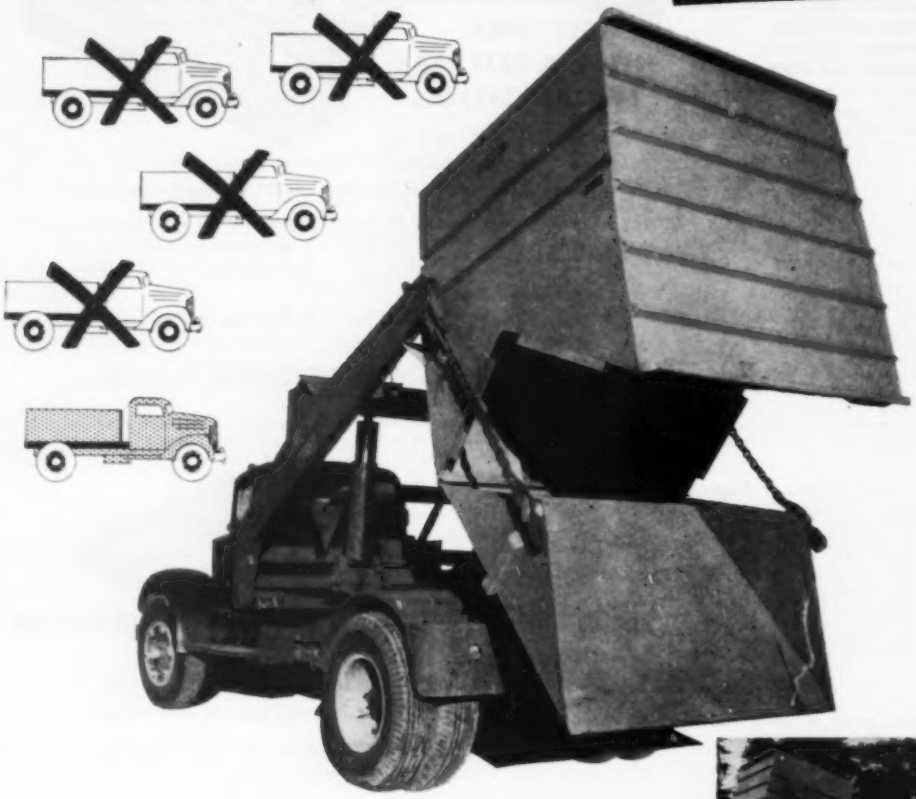
DEMPSTER DUMPSTER



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bon oxides is cooled to condense normally liquid components and to form a gas phase, an oily liquid phase, and an aqueous liquid phase. After separating these phases, the oily phase is extracted with an aqueous liquor including dissolved organic oxygenated compounds. A raffinate comprising hydrocarbons, and an extract comprising additional oxygenated organic compounds are formed. This extract is combined with the above named aqueous phase. Organic acids and non-acidic organic compounds contained in the resulting mixture are separated from each other.

U.S.P. 2,577,563. Preparation of Hydrogen-Carbon Oxide Mixtures and Catalytic Reaction Thereof. A. Belchetz to The M. W. Kellogg Company.

Details are claimed of a process for the production of synthesis gas from a methane-containing gas stream, and for the production of organic compounds from the synthesis gas.

U.S.P. 2,577,634. Recovery of Hydrocarbons from Gaseous Streams. W. G. Scharmann to Standard Oil Development Company.

Details are claimed of a process for the recovery of valuable hydrocarbons from the tail gases of a hydrocarbon synthesis operation.

U.S.P. 2,578,144. Catalyst for the Reaction of Carbon Monoxide and Hydrogen with Unsaturated Compounds. W. A. McMillan to The Texas Company.

Olefins are reacted with CO and H_2 in the presence of a cobalt salt of acetyl acetone. Carbonylic compounds are produced.

U.S.P. 2,578,475. Production of Gas Comprising Hydrogen and Carbon Monoxide. J. H. Hirsch and M. J. Boegel to Gulf Research and Development Company.

A H_2/CO gas mixture with a high H_2 to CO ratio is produced in a spark ignition internal combustion engine from a preformed charge mixture of oxygen and hydrocarbon fuel by a process claimed in detail.

U.S.P. 2,578,704. Reforming of Hydrocarbons with Dehydrogenation Catalysts. E. J. Houdry to Houdry Process Corporation.

Liquid hydrocarbons boiling in the range of gasoline and naphthas are contacted in vapor phase under dehydrogenating conditions at elevated pressure with a coke-containing catalyst in the presence of added hydrogen-rich gas. The coked catalyst shall have a higher temperature than the hydrocarbons to raise the tempature of the latter to and within dehydrogenation temperature range. The thus partially dehydrogenated hydrocarbons are then contacted with freshly regenerated dehydrogenation catalyst of higher temperature than the coke-containing catalyst. A normally liquid hydrocarbon fraction of higher octane rating than the charge material is separated.

U.S.P. 2,579,010. Hydrogenation of Thiophenic Compounds Containing an Unsaturated Side Chain. H. Pines and B.

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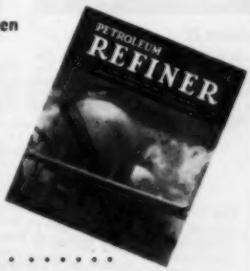


ABP

One of a series of advertisements prepared by THE ASSOCIATED BUSINESS PUBLICATIONS

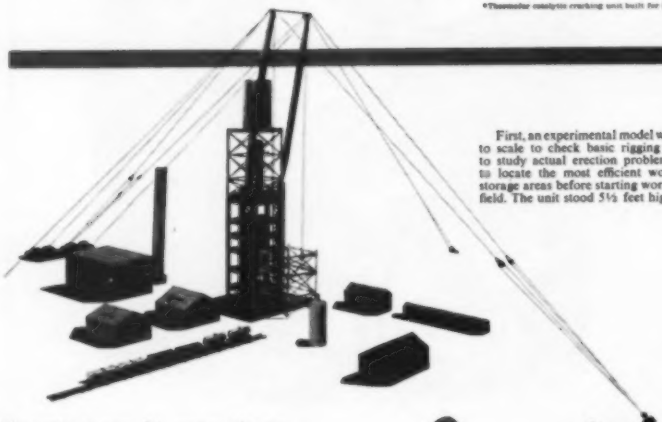
It took 60 years to save three months

on Socony's new cat-cracker*

The cat-cracker, the most important processing unit in a refinery today, is usually built from the ground up like a skyscraper—one or two floors at a time. But Fluor has developed a new time-saving technique of designing the component parts so that they can be fabricated on the ground simultaneously and lifted into place, thereby making more efficient use of manpower and equipment. Construction crews work in perfect coordination on a production-line basis to effect substantial savings in construction costs, but above all *in time!*

Fluor designed and constructed the catalytic cracking unit shown here for Socony-Vacuum at Augusta, Kansas. It stands 268 feet high, equivalent to a 22-story building. Nine months and 13 days after foundation was poured, it went on stream for 15,000 barrels a day, three months earlier than could be normally expected if built by conventional methods under similar circumstances. This airlift TCC unit processes about 1½ million barrels of oil in three months; that's why getting it into operation in the shortest possible time was an all-important objective.

*Thermofor catalytic cracking unit built for Socony-Vacuum Oil Company at their Augusta, Kansas refinery.



First, an experimental model was built to scale to check basic rigging design, to study actual erection problems, and to locate the most efficient work and storage areas before starting work in the field. The unit stood 5½ feet high.

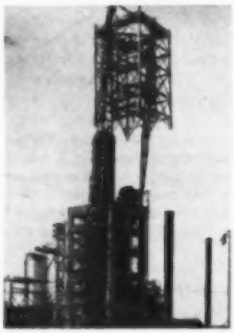
October 26

Reinforced concrete was used to a height of 100 feet for fire protection. While the base was being poured (August 21, 1950), these concrete panels weighing 85 tons each were being cast on the ground slab.

Here's how it was done— from conception to *Completion*

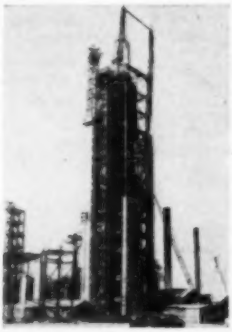
December 22

In spite of sub-zero weather, the building marathon continues. The Reactor weighing 100 tons is being hoisted 100 feet into the air. It took less than an hour to complete this operation. The cracking process takes place in this unit.



January 4

This steel section, assembled on the ground and weighing 110 tons, was lifted 160 feet and lowered into place over the Reactor. It supports the Hot Catalyst Bin. This is one of 28 major lifts varying in weight from 60 to 125 tons.



March 5

After the last steel section was set, the Separator Surge Drum (63 tons) is raised into place on top. This was the last lift to be made. Total height is now 268 feet, 22 stories high, and is one of the tallest structures in Kansas.

May 10

Operation testing completed and ready for start up, 9 months and 13 days after foundation was finished. This cat-cracker is capable of processing 630,000 gallons of oil every day. Fluor has four more similar units under way.

For 60 years Fluor has been building for industry and is among the leaders in plant construction for the oil, gasoline, chemical and power industries in and out of the continental United States. If time-saving is your concern, take time to contact your nearest Fluor district office for details. Write for Bulletin CC2521 describing Fluor activity in the construction of Fluid and Thermofor cat-crackers.

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Kvetinskas to Universal Oil Products Company.

A thiophenic compound containing an unsaturaed side chain is hydrogenated in this chain only by reacting the compound and hydrogen at a temperature of 30-250° C. and elevated pressure in the presence of a palladium-alumina catalyst.

U.S.P. 2,579,663. Process of Synthesizing Hydrocarbons. W. I. Gilbert and C. W. Montgomery to Gulf Research and Development Company.

A mixture of CO and steam having a mole ratio of CO:H_2O of about 2:1 is contacted with an iron catalyst reduced from the oxide to about 50-100 percent or a cobalt catalyst correspondingly reduced to about 40-80 percent at a pressure of 100-600 psi. and a temperature of 500-600° F. Normally liquid hydrocarbons are recovered.

U.S.P. 2,579,828. Synthesis of Organic Compounds. W. B. Johnson to The M. W. Kellogg Company.

Details are claimed of a Fischer-Tropsch synthesis process wherein unreacted CO/H_2 mixture from a first reaction zone is contacted in a second zone with catalyst from the first zone contacted before with a hydrogen-containing gas for stripping therefrom high-boiling organic compounds.

U.S.P. 2,579,843. Method for the Manufacture of Synthesis Gas. C. K. Mader to The M. W. Kellogg Company.

Details are claimed of a process for the conversion of methane to a CO/H_2 mixture of a H_2:CO ratio between 1:1 to 3:1. Preheated methane is reformed with steam, and the reforming effluent containing CO and H_2 formed is then further treated at higher temperatures.

U.S.P. 2,580,039. Method of Production of An Iron Catalyst for Hydrocarbon Synthesis. R. C. Morbeck to Standard Oil Development Company.

In a Fischer-Tropsch synthesis at a temperature of 675-750° F., the catalyst is formed by a dense turbulent mass of finely divided reduced fresh red iron oxide particles of fluidizable size sintered in an atmosphere of hydrogen at a temperature of 1550-1650° F. and promoted with a minor amount of an alkali carbonate. The sintering is effected subsequent to the reduction and, if desired, after addition of the promoter. The catalyst has very low carbon formation tendencies.

U.S.P. 2,580,116. Synthesis of Organic Compounds. H. G. McGrath and L. C. Rubin to The M. W. Kellogg Company.

In a Fischer-Tropsch synthesis process in the presence of a finely-divided alkali-containing reduced iron catalyst having no more than a minor proportion by weight of material with a particle size greater than 250 microns, the feed mixture of H_2 CO and CO_2 is passed upwardly through the catalyst at a velocity effective to suspend the catalyst in the gases in a dense fluidized condition. More details are claimed.

DESULFURIZATION

U.S.P. 2,575,989. Treatment of Petroleum Distillates. E. Arundale and J. P. Thorn to Standard Oil Development Company.

Mercaptan compounds are removed from petroleum oil by contacting the oil first with an alkali metal hydroxide solution and then with a specific type alkylene oxide such as ethylene oxide in the presence of an alkaline catalyst.

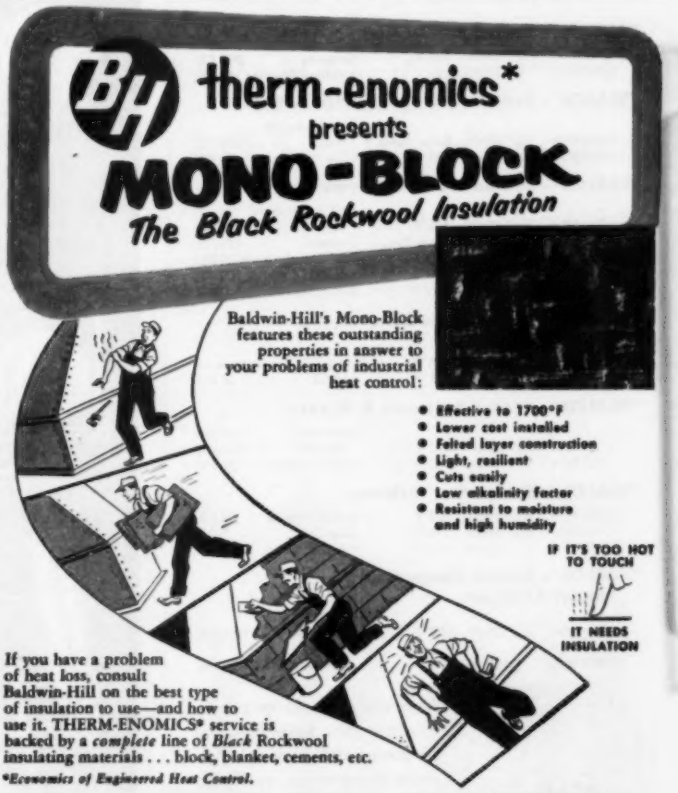
U.S.P. 2,577,823. Hydrodesulfurization of Sulfur-Containing Hydrocarbon Fractions. H. M. Stine to The Standard Oil Company (Ohio).

For desulfurizing heavy hydrocarbon oil fractions containing 1-6.5 percent S as organic sulfur compounds, these fractions are treated under certain conditions of temperature and pressure in the presence of added hydrogen with a contact mass consisting of specific amounts of Cr, Mo, and Al oxides.

U.S.P. 2,577,824. Process of Removing Mercaptans from Hydrocarbons with Alkali Impregnated Charcoal. H. M. Stine to The Standard Oil Company (Ohio).

Hydrocarbons containing mercaptans are contacted in the liquid phase with charcoal impregnated with an aqueous solution of a strongly alkaline base. The mercaptans are adsorbed on the charcoal as mercaptides and thereby separated from the hydrocarbons.

U.S.P. 2,578,602. Dethiolizing Hydrocar-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3,500 RPM	¾" Shaft	150°F	Aviation Gasoline	60 PSI

"SEALOL"– Sealed Hydraulic Pumps & Motors

1,800 RPM	1⅛" Shaft	Room Temp.	Ucon Hydraulic Fluid	1500 PSI
11,000 RPM	2¼" Shaft	200°F	Lube Oil	20 PSI

"SEALOL"– Sealed Transfer Pumps

1,750 RPM	2½" Shaft	200°F	Acid and Caustic Dye Liquors	15 PSI
3,500 RPM	1⅛" Shaft	Room Temp.	Propane	350 PSI
1,750 RPM	1" Shaft	600°F	Heat Transfer Fluid	50 PSI
1,800 RPM	1" Shaft	200°F	Brine	100 PSI
60 RPM	½" Shaft	70°F	Sulfur Dioxide	100 PSI

"SEALOL"– Sealed Gear Boxes & Speed Reducers

6,800 RPM	5" Shaft	125°F	Lube Oil	Atmos. Pressure
18,000 RPM	1¼" Shaft	150°F	SAE 10	20 PSI

"SEALOL"– Sealed Agitators & Mixers

80 RPM	2¾" Shaft	350°F	Steam and Hot Air	Atmos. Pressure
300 RPM	1" Shaft	450°F	Acetone Vapor	50 PSI

"SEALOL"– Sealed Gas Turbines

15,000 RPM	1⅝" Shaft	300°F	Alcohol Vapor	65 PSI
7,700 RPM	5¼" Shaft	356°F	Lube Oil	2 PSI
53,000 RPM	1" Shaft	350°F	Oil and Steam	350 PSI

"SEALOL"– Sealed Compressors & Super-Chargers

3,024 RPM	3½" Shaft	250°F	Oil Mist and Air	7½" Hg. abs.
70,000 RPM	½" Shaft	230°F	Oil Mist and Air	19" Hg. abs.

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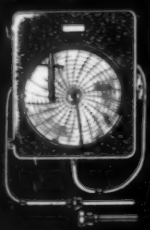

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bons and Other Organic Liquids. L. Rosenstein to Texaco Development Corporation.

Hydrocarbons to he dethiolized are countercurrently contacted with an anhydrous alkanolamine solution of alkali metal hydroxide limited in quantity to supply about the stoichiometric amount of the hydroxide based on the mercaptan content of the hydrocarbons. The mercaptans are completely removed.

HEAVY OILS AND WAXES

U.S.P. 2,575,003. Fuel Oil Composition. J. B. R. Caron, E. B. Glendenning, and C. Wies to Shell Development Company.

A fuel oil containing entrained moisture and normally tending to cause clogging contains 0.0025-0.005 percent of aluminum or iron petroleum naphthenate, and 0.0015-0.004 percent of sodium petroleum sulfonate to inhibit clogging.

U.S.P. 2,575,543. Diesel Starting Fluid. H. D. Young to Sinclair Refining Company.

A starting fluid for compression-ignition engines contains 15-50 percent by volume of diethyl ether and 85-50 percent of a predominantly straight chain paraffinic, low pour point closely cut light petroleum fraction boiling between about 100-350° F. and containing one of normal C_7, C_8, C_9 or C_{10} cuts.

U.S.P. 2,575,718. Method of Producing Polyolefinic Hydrocarbon Drying Oils. R. J. Lee and P. S. Drennan to Pan American Refining Corporation.

A synthetic drying oil of specific characteristics is produced from a hydrocarbon charging stock free from aromatics by treatment with HF at a temperature of 250-450° F. and under certain conditions claimed in detail.

U.S.P. 2,575,992. Polymeric Lubricating Oil Additives. J. H. Barlett to Standard Oil Development Company.

A waxy mineral lubricating oil contains a small amount of a copolymer of four parts by weight of a triester of aconitic acid wherein at least one ester group contains 8-18 saturated C atoms and one part of vinyl acetate. The copolymer has a molecular weight of 1,000-50,000. It depresses the pour point of the oil.

U.S.P. 2,576,031. Lubricating Grease Containing Soaps of Tall Oil. A. J. Morway and J. J. Kolfenbach to Standard Oil Development Company.

Mineral lubricating oil is thickened to grease consistency with a combination of 5-20 percent by weight of tall oil sodium soaps and the sodium salt of a low molecular weight cyclic carboxylic acid.

U.S.P. 2,576,032. Lubricating Grease. A. J. Morway and D. W. Young to Standard Oil Development Company.

A lubricating grease consists of certain proportions of a mineral lubricating oil, an alkali metal salt of a cycloalkanoic acid with 3-6 C atoms in the ring and a molecularweight not greater than 160, and the same alkali metal soap of fatty acid with 12-24 C atoms.

U.S.P. 2,576,033. Preparing High-Temperature Lubricating Greases. A. J. Morway and J. Kolfenbach to Standard Oil Development Company.

Details are claimed of a process for the production of a lubricating grease from mineral lubricating oil, a heterocyclic aldehyde, such as furfural, and an alkali base to form Canizzaro reaction products.

U.S.P. 2,576,458. Stabilized Organic Compositions. E. F. Hill and F. H. Baldwin to Ethyl Corporation.

A petroleum hydrocarbon fuel contains a substituted ethanol amine of certain constitution, such as phenyl ethanol p-hydroxyphenyl amine. The additive inhibts deterioration of the fuel in the presence of oxygen.

U.S.P. 2,577,643. Wax Compositions. D. W. Young and A. J. Morway to Standard Oil Development Company.

Refined paraffin wax is compounded with 1-5 percent of an alkali metal or alkaline earth salt of a low molecular weight heterocyclic carboxylic acid having a five-membered furan-type ring. High temperature stability of the wax is improved and its tensile strength is increased by the additive.

U.S.P. 2,577,706. High Melting-High-Water-Resistant Grease. B. W. Hotten to California Research Corporation.

A lubricating grease formed from a lubricating oil and an organic acid alkali

Patents

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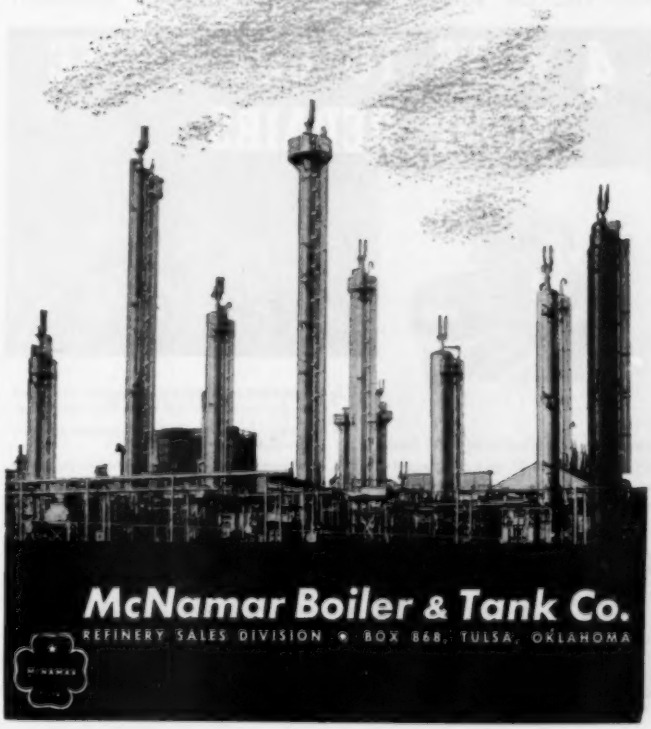

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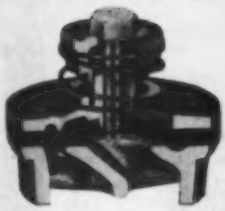

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Patents

metal salt thickening agent contains a small amount of a certain type of a polymeric compound containing carboxyl or carboxy-ester groups partly saponified by alkaline or alkaline earth metals. The additive improves the resistance of the grease to emulsification with water.

U.S.P. 2,577,719. Lubricating Compositions Containing Dicarboalkoxy-Diheptadecyl Selenides. W. T. Stewart to California Research Corporation.

A hydrocarbon lubricating oil contains 0.1-2 percent by weight of 1,1'-dicarboalkoxy-8,8'(-or -9,9'-)heptadecyl selenide, or mixtures thereof, wherein the alkoxy groups have not more than 8 C atoms. The additives have antioxidant and anti-corrosive properties.

U.S.P. 2,578,214. Drying Oil Composition. J. P. West to Universal Oil Products Company.

A drying oil composition comprises (1) 20-95 percent of a normally non-drying hydrocarbon oil containing a certain mixture of polyolefins and (2) 5-80 percent of a mixture of polyolefinic cyclic hydrocarbons obtained in a specific manner.

U.S.P. 2,578,689. Lubricant Containing a Reaction Product of Water-Soluble Sulfonic Acids and Phosphorus Sulfide. M. W. Freeman.

A mineral lubricating oil contains a minor amount of a reaction product obtained from a water-soluble petroleum sulfonic acid and 10-40 percent of phosphorus sulfide at elevated temperature below 450° F. The additive imparts extreme pressure and corrosion inhibiting properties to the lubricant.

U.S.P. 2,579,007. Process for Modifying Unsaturated Hydrocarbon Drying Oils. M. J. Murray and W. S. Gallaway to Universal Oil Products Company.

A drying oil comprising a mixture of cyclic, polyolefinic hydrocarbons recovered from a catalyst-hydrocarbon sludge formed in a conjunct polymerization is contacted with a catalyst containing adsorptive silica, at conditions suitable for effecting isomerization - polymerization of the hydrocarbon components. The properties of the drying oil are improved.

U.S.P. 2,579,037. Lubricating Composition. E. A. Evans and J. S. Elliott to C. C. Wakefield and Company, Ltd., London.

A mineral oil base lubricant contains a small amount of an oil-soluble salt of an organic dithiophosphoric acid of certain constitution. The additive inhibits bearing corrosion and oxidation of the oil and reduces deposition of gum, lacquer and carbon.

U.S.P. 2,579,038. Lubricant Composition. E. A. Evans and J. S. Elliott to C. C. Wakefield and Company, Ltd.

A hydrocarbon lubricant contains 0.05-2.0 percent by weight of a tin salt of an oil-soluble petroleum sulfonic acid and 0.1-2 percent of an oil-soluble chromium salt of an octylcresyl dithiophosphoric acid.

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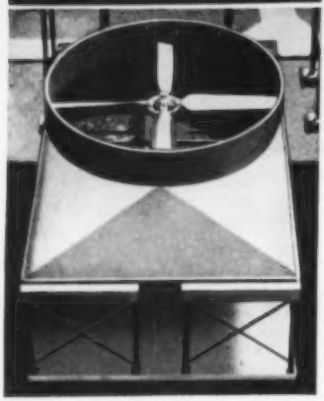

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(name and type of equipment to be cooled)

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Title .....
Company .....
City ..... Zone ... State .....

Patents

U.S.P. 2,579,501. Separation of Wax by Filtration with Fuel Gas Chilling. W. W. Kraft to The Lummus Company.

Details are claimed of an improved continuous process for separation of wax from a chilled mixture of wax, oil and solvent by filtration in an atmosphere of flue gas.

U.S.P. 2,579,890. Nonclogging Distillate Fuel Oil. C. Wies, J. B. R. Caron, and E. B. Glendenning to Shell Development Company.

A distillate fuel oil containing entrained moisture and tending to cause clogging is rendered non-clogging by incorporating therein a minor amount (e.g. 0.0025-0.005 percent) of a salt of unsubstituted sulfoaliphatic carboxylic acid ester, such as dioctyl sodium sulfosuccinate.

U.S.P. 2,580,005. Extreme Pressure Lubricating Compositions. E. B. Cyphers and G. M. McNulty to Standard Oil Development Company.

A mineral base lubricating oil contains 1-20 percent by weight (of the total composition) of an extreme pressure additive consisting of a sulfurized fatty oil treated with 0.5-2 percent of a phosphorus sulfide at a temperature of 170-210° F., and 0.1-2 percent of a metal deactivator.

U.S.P. 2,580,015. Diesel Fuel. R. S. George to Hercules Powder Company.

A liquid fuel for compression ignition engines comprises a major amount of hydrocarbon diesel fuel and 0.25-5 percent by weight (based on the total composition) of an alpha, alpha-dialkylarylmethyl hydroperoxide. The composition has an increased cetane value.

U.S.P. 2,580,036. Rust Inhibiting Composition. A. H. Matuszak and J. W. Hand, Jr., to Standard Oil Development Company.

A mineral lubricating oil contains 0.01-10 percent of pentaerythritol monooleate and 0.001-5 percent of propylene diamine.

U.S.P. 2,580,038. Mineral Oil Containing Resinified Esters of Salicylic Acid. L. A. Mikeska to Standard Oil Development Company.

A mineral lubricating oil contains a minor amount of a product formed by subjecting a salicyclic acid ester the alkyl group of which is formed by a straight chain aliphatic hydrocarbon radical having 8-24 C atoms, to a temperature of 50-250° C. for 2-20 hours in the presence of an equimolecular proportion of formaldehyde, or the like. The additive has pour point depressing properties.

U.S.P 2,580,053. Mineral Oil Containing Copolymers of Alpha-Beta Unsaturated Dicarboxy Esters with Alpha-Beta Unsaturated Monocarboxy Acids. T. S. Tutwiler, J. C. Munday, and D. T. Rogers to Standard Oil Development Company.

A mineral lubricating oil contains 0.01-15 percent by weight of an oil soluble homogeneous copolymer formed from diethyl fumerate and octyl, decyl methacrylate in the presence of a benzoyl peroxide catalyst, or from similar compounds. The additive improves the viscosity index and depresses the pour point of the oil.

U.S.P. 2,580,274. Lubricant. R. F. Bergstrom and J. M. Plantfeber to Shell Development Company.

A lubricating oil contains minor amounts of an oil soluble calcium salt of a condesnation product of an alkyl phenol with formaldehyde and zinc dibutyl dithiocarbomate, and of a hydrocarbon aromatic amine and an oil-soluble salt of a petroleum sulfonic acid. The additives prevent deterioration of the oil.

U.S.P. 2,580,288. Anticorrosion Compositions. M. Fainman to Standard Oil Company (Indiana).

A mineral lubricating oil contains 0.001-5 percent of a dialkoxy diaminosilane in which the alkoxy groups contain 1.20 C atoms. The additive has anticorrosion properties.

PETROCHEMICALS

U.S.P. 2,575,556. Method for Producing and Refining Ethyl Alcohol. R. L. Maycook and C. L. Dunn to Shell Development Company.

Details are claimed of a method of producing ethanol from gaseous ethylene and water vapor at elevated temperature and pressures in the presence of an acid catalyst.

U.S.P. 2,576,113. Processes for the Production of Oxygenated Compounds. H. J. Hagemeyer, Jr., to Eastman Kodak Company.

An aliphatic olefin, such as ethylene, is reacted with CO and H_2 at temperatures of 50-250° C. and 40-700 at pressure in the presence of a catalyst containing Co or Fe and an alkali metal salt of a carboxylic acid as a buffering agent. Aldehydes are produced.

U.S.P. 2,576,535. Treating Olefins with Alkanesulfonic Acid. W. A. Proell to Standard Oil Company (Indiana).

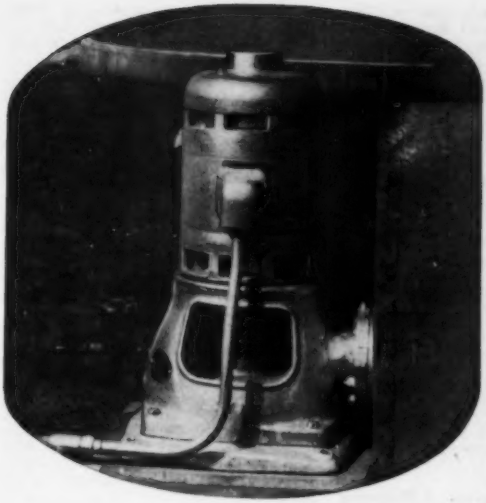
A hydrocarbon stream containing secondary olefin and ethylene is contacted at a temperature of 40-140° F. for 10-60 minutes with an alkanesulfonic acid containing not more than 5 C atoms and having an acid concentration of more than 80 percent. The secondary olefin is thereby reacted with the acid to form an alkanesulfonic acid ester phase. Unreacted ethylene is removed from this phase.

U.S.P. 2,576,625. Production of Polycarboxylic Acid Products. R. J. Miller to California Research Company.

A gaseous mixture of air and durene, wherein the weight of air is 30-200 times that of durene, is contacted with a vanadium oxide catalyst disposed on an inert solid support at a temperature of 850-1050° F. and a rate such that 0.05-3.0 moles of durene are contacted with 50-100 cc. catalyst per hour. Pyromellitic anhydride is produced.

U.S.P. 2,576,895. Preparation of Ureides. D. E. Adelson to Shell Development Company.

Biuret is reacted with either an iso-



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alkyl-aryl hydrocarbon, an isoalkane, an 1-alkine, an aralkylidyne-methane hydrocarbon, or a polyarylmethane, or indene hydrocarbon at a temperature of 50-350° C. An allophanyl-substituted hydrocarbon is produced while ammonia is set free.

U.S.P. 2,577,053. Method of Oxidizing Hydrocarbons. J. C. Walker to Cities Service Oil Company.

A feed stock comprising normally gaseous hydrocarbons above methane is passed together with admixed oxygen-supplying gas at elevated pressure through a plurality of reactors arranged in series. The gases entering the first reactor are heated to a temperature favoring partial oxidation of the hydrocarbons. Heat generated in each reaction stage except the last is removed from the gaseous stream while maintaining the temperature of the gases at a value favoring said partial oxidation until the gases have passed through all reactors. Oxygenated hydrocarbon compounds are obtained.

U.S.P. 2,577,208. Production of Ketonic Bodies. W. Reppe and A. Magin.

An olefin, e.g. a low mole weight aliphatic olefin, is reacted with CO and H_2O in the presence of a complex nickel-cyanide catalyst, e.g. a complex alkali metal nickel-cyanide catalyst, at a temperature of 100-250° C. and a pressure of at least 10 atmospheres. Ketonic compounds are formed.

U.S.P. 2,578,654. Preparation of Tertiary-Alkyl-Substituted Benzene Carboxylic Acids. G. W. Hearne, T. W. Evans, and V. W. Buls to Shell Development Company.

A stream of a molecular oxygen-containing gas is intimately contacted with a liquid tert-alkyl toluene wherein the tert-alkyl group is the only substituent, at a temperature of 130-225° C. under pressure up to 1000 psi. in the presence of 0.005-5 percent by weight of a soluble salt of a heavy metal. The corresponding tert-alkyl benzoic acid, e.g. p-tert.-butylbenzoic acid, is recovered when not over 70 percent of the toluene compound has been consumed.

U.S.P. 2,578,657. Process for Producing Sulfonic Acids and Sulfonates. H. W. Anderson, O. A. Samson and A. W. Clark to Shell Development Company.

Details are claimed for the production of an oil solution of oil-soluble petroleum sulfonic acids from a mineral lubricating oil raffinate fraction of naphthenic character and special physical characteristics by treatment with fuming sulfuric acid.

U.S.P. 2,578,759. Process of Preparing Polycarboxylated Naphthalene Derivatives. J. M. Straley and C. W. Wayman to Eastman Kodak Company.

Bridged naphthalene hydrocarbons, such as acenaphthene, are contacted with a catalyst solution comprising a lower aliphatic acid containing cobalt ions and activated by a lower aliphatic aldehyde, in the presence of an oxygen-containing gas at a temperature of 50-120° C. The corresponding polycarboxylated naphthalene derivative is formed.

U.S.P. 2,578,823. Preparation of Phenols. V. Molinari and H. G. Affholter to Union Carbide and Carbon Corporation.

Phenol is produced by treatment of benzene with oleum in a process details of which are claimed.

U.S.P. 2,578,841. Production of Ethylene Oxide. N. C. Robertson and R. T. Allen to Celanese Corporation of America.

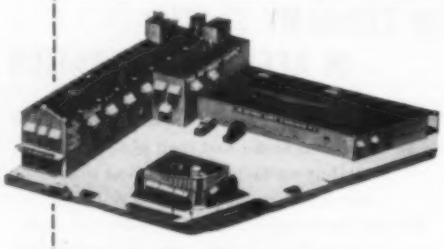
Details are claimed for the production of ethylene oxide from a mixture of ethylene and air in the presence of a catalyst comprising an inactive alumina carrier and a deposit of certain amounts of silver, barium peroxide and zinc oxide.

U.S.P. 2,578,913. Fluorination of Hydrocarbons. G. M. Whitman to E. I. du Pont de Nemours and Company.

A mixture of a paraffin hydrocarbon, HF, and oxygen is heated to a temperature of 325-700° C. in the presence of an inorganic salt or oxide of a variable valent metal, such as CuO on alpha-alumina. Fluorinated hydrocarbons are produced.

U.S.P. 2,579,601. Olefin Hydration Process. C. R. Nelson, M. A. D. Taylor, D. D. Davidson, and L. M. Peters to Shell Development Company.

In the production of alcohols from olefins and water in the gaseous state, a catalyst bed is employed which comprises phosphoric acid absorbed within a porous carrier. A solution of free phosphoric acid is added to the carrier as



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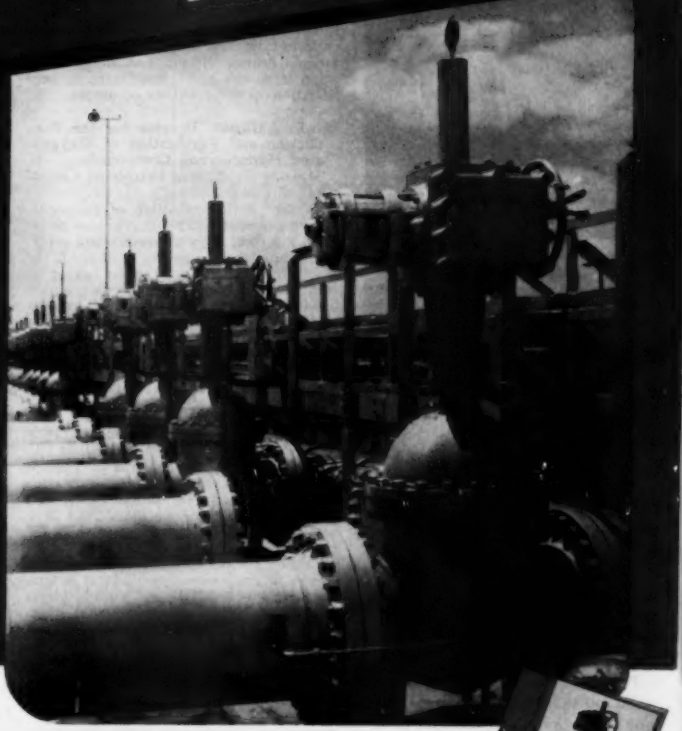

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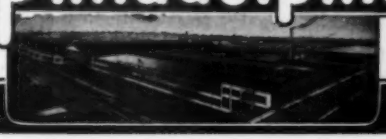

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Patents

the hydration operation continues to make up for the loss of this acid caused by passing the gaseous feed mixture therethrough. The amount of added acid shall not exceed one pound (calculated as 100 percent H_3PO_4) for each 100 pounds of alcohol produced.

U.S.P. 2,579,638. Production of Acrylic Nitrile. J. P. Zwilling, H. Bassoli, and C. Granger to Pechiney-Co. de Produits Chimiques et Electrometallurgiques.

Details are claimed of a process for obtaining acrylic nitrile by reacting acetylene with HCN in the presence of a cuprous salt solution, vinylacetylene formed during the reaction being separated from the reaction effluent by rectification in the presence of steam.

U.S.P. 2,579,847. Process for the Production and Purification of Oxygenated Hydrocarbon Compounds. C. R. Murphy to Warren Petroleum Corporation.

In the partial oxidation of hydrocarbons to produce gaseous reaction products, the formation of acetals and esters is inhibited by removing acid from the reaction mixture as rapidly as it is formed by cooling the gaseous reaction product by heat exchange with recycle stock to a temperature below the dew point of the acids and color bodies.

ISOMERIZATION

U.S.P. 2,579,669. Catalytic Isomerization of Acetylenic Hydrocarbons. J. C. Hillyer and J. F. Wilson to Phillips Petroleum Company.

A mixture of HF and an acetylenic hydrocarbon having no more than 20 C atoms, in a molar ratio of less than 1:1, is contacted with an aluminum oxide or aluminum fluoride catalyst or a composite of the two compounds at a temperature of 300-700° F. An acetylenic hydrocarbon of the same skeletal structure is obtained containing an acetylenic linkage in a more central position than the charge material.

ALKYLATION

U.S.P. 2,578,294. Process of Producing 3,4-Dimethyl 1-Ethyl Benzene. W. E. Elwell to California Research Corporation.

Ortho-xylene is contacted with ethylene in the presence of an Al Cl_3 catalyst, while a mole ratio of ethylene to o-xylene of about 2:1, a temperature of 90-95° C. and a catalyst concentration of 0.015-0.035 mole of catalyst per mole of xylene are maintained. 3,4-Dimethyle 1-ethyl benzene is produced and isomerization of the methyl groups is substantially avoided.

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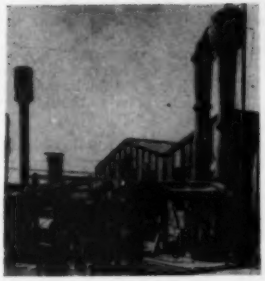

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Review and Comment for the Process Man

Progress Report for 1949

Reviews of Petroleum Technology, Volume 11 (Covering 1949). Institute of Petroleum, 26 Portland Place, London, W. 1. $4.

Volume 11 contains a valuable and critical record of the progress made in the science and technology of petroleum during the year 1949. The book reflects literature research, and provides references to nearly 3000 technical papers and articles.

Where necessary to trace full development, the volume reflects progress for previous years, i.e., the present volume reviews plant instrumentation for the period 1947 to 1949; crude oils for the same period, and insulating and hydraulic and bitumen for the years 1948 and 1949.

Russian Chemical Development

Progress of Acetylene Chemistry in U.S.S.R., I. N. Nazarov, *Progress of Chemistry*, **20,** 309-335 (1951). Associated Technical Services, P. O. Box 271, East Orange, N. J. $31.80.

A comprehensive review of the most important achievements of acetylene chemistry attained at the Laboratory of the Institute of Organic Chemistry, Moscow, during the past 15 years is reported by I. N. Nazarov in *Uspekhi Khimii* (Progress of Chemistry) and translated into English by the Associated Technical Services.

Topics covered include hydration of divinylacetylenic hydrocarbons to vinyl allyl ketones and their new reactions; isomerization of vinylethynylcarbinols to divinyl ketones; selective hydrogenation of vinylethynyl carbinols to 1,3-dienic alcohols, and others.

New Hydrocarbon Data

Light Hydrocarbon Analysis, edited by O. W. Burke, Jr., C. E. Starr, Jr., and F. D. Tuemmler, Reinhold Publishing Corporation, 330 West 42 Street, New York. $15.

This book is a large collection of specific analytical procedures in the field of light hydrocarbons. Included in an illustrative manner are various schemes of analysis employing these methods for a complete assay of highly complex hydrocarbon mixtures. Entirely new information offers valuable and complete data on the accuracy and precision of the methods employed.

"Black Oils" Research

Petroleum Desulfurization, Henry Rakoff, Bulletin No. 4, June, 1951, Natural Resources Research Institute, The University of Wyoming, Laramie.

Inspired by the 1948-49 annual report of the NRRI to undertake research work of interest to operators concerned with the up-grading of "black oils," the Institute was able in July, 1950, to initiate a project dealing with sulfur removal from petroleum. This literature survey, a result of the prject, is presented because to date no bibliography is generally available.

Divided into four parts, Part I pertains to abstracts from journals, listing 416 in all, and is listed alphabetically by author. Part II follows the same procedure in listing patents, about 961 of which are listed. A numerical patent index by countries is presented as Part III and a subject index as Part IV.

The book is available from the Institute alone.

Oil and Free Enterprise

Magic Oil, Servant of the World, by Alfred M. Leeston, Juan Pablos Books, Dallas, Texas. $3.75.

Striking a blow for the American system of competitive free enterprise, the author summarizes the development of the oil industry throughout the world, with a brief summary of the various political and economic aspects of the Middle East. Leeston, who discusses the oil industry in every country of the world, including Russia, has traveled in most of these places, or contacted persons who have. He lists his extensive

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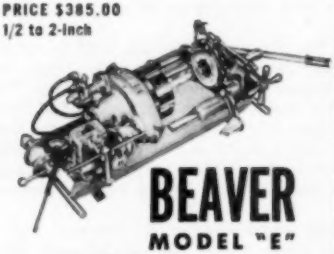

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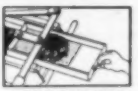
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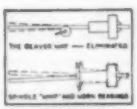
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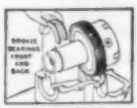
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WILSON

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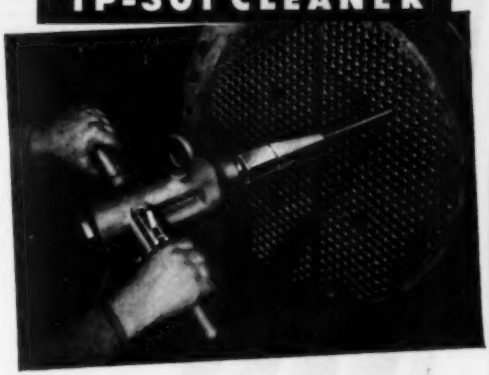

This high speed tube cleaner is designed to increase output and minimize down-time. The improved Model TP-301 is the only tube cleaner which can remove deposits from completely plugged heat exchanger tubes . . . and other fouled straight tubes heretofore not considered practical to clean.

Many improvements, resulting from years of field experience, have been built into the new TP-301 cleaner.

- **MORE POWERFUL**—operating speed up to 3500 RPM at 90 psi utilizing 130 cfm.
- **LIGHTER WEIGHT**—only 15 lb.
- **SHORTER**—only 13" overall.
- **INCREASED CAPACITY**—from 3/8" up to 2½" or even 3" O.D. tubes up to 40 ft. in length.
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- **LOW HEAD ROOM NEEDED**—minimum practical working head room 5 ft.
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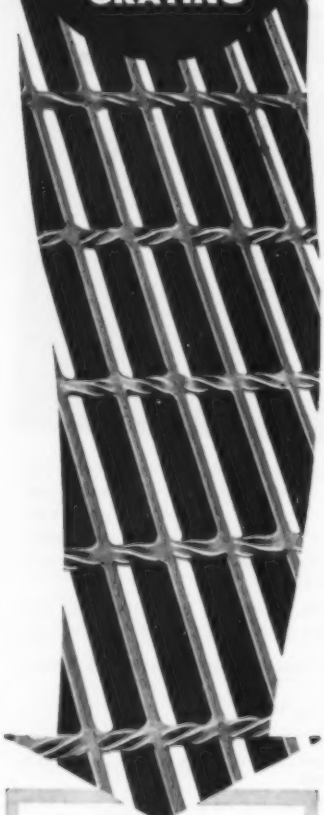

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Books

bibliography of references in the back of the book.

Graphics for Engineers

Engineers' Illustrated Thesaurus, Herbert Herkimer, Chemical Publishing Company, Inc., 212 Fifth Avenue, New York. $6.

Following the advice of William Kent to compile a pocket-data book as he proceeded in study and practice, the author after 30 years of gathering data had a sizeable collection from which to draw his material. The text in the volume is kept to a minimum in order to encompass as many graphic illustrations as possible in a limited space.

Information Committee Has Radio Series Available

"Romance of Oil—The Story of an Industry" is the name of the series of 13 transcribed radio programs produced by the Oil Industry Information Committee and available for local sponsorship on local radio stations.

Produced by a skilled cast, the programs re-create great moments in the oil history—how and why men go out to the open plains or into strange places to explore, lease, drill and develop potential oil fields; the intricacies of refining crude into thousands of useful products; scientists at work in the industry's laboratories.

Each of the programs is timed at 13 minutes and 20 seconds to accommodate the sponsor's commercials. The series is recorded two programs on a platter, back to back. They may be obtained through the district offices of the Oil Industry Information Committee, or through the national headquarters in New York, 50 West 50th Street, New York 20.

G-E Offers Maintenance Film

Augmenting its recently announced Productive Maintenance Program, General Electric now offers a 12-minute, black-and-white, sound slidefilm on the subject for showings to interested groups.

Called "Productive Maintenance," the film presents a quick, visual report, includes three case histories showing how the program is being put to use in industrial plants, and reviews the plan's six major recommendations for good maintenance.

Arrangements for a showing can be made through any of the company's apparatus sales offices or service shops.

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About EQUIPMENT and SERVICE Suppliers

Capstick Named St. Louis Area Representative for Lectrodryer

With headquarters in St. Louis, D. W. Capstick has been named representative for the Pittsburgh Lectrodryer Corporation to serve the St. Louis, Southern Illinois, and Evansville, Ind., areas. Capstick has been a manufacturer's agent in St. Louis since 1944, and is a professional engineer licensed in Minnesota, Missouri and Ohio. He is a graduate of the University of Minnesota School of Engineering, and was associated with Morgan Gerrish Company for 12 years, and with Frigidaire Division of General Motors Corporation.

Capstick

Timken Promotes George Muntean

The Timken Roller Bearing Company has promoted George J. Muntean to assistant superintendent of the Canton (Ohio) Bearings factory. Muntean has been a Timken employe since graduating from high school in 1933.

Hercules Powder Executive Retires With 30 Years Service

Petrus W. Meyeringh, vice president, director, and member of the executive committee of Hercules Powder Company, who retired last month for reasons of health, ended an association with Hercules Powder Company which began nearly 30 years ago in The Hague, Holland.

Albert E. Forster has been elected a vice president and member of the executive committee of Hercules Powder Company to fill the vacancy created recently when Petrus W. Meyeringh retired because of ill health. Forster has been associated with the company since 1925 and has served in the sales, technical service and production phases of the Explosives Department, as well as executive positions in several plants and sales offices. For the past 11 years he has been general manager of the Naval Stores Department and was elected to the board of directors in 1941.

Anning Named Sales Engineer Of Rockwood Ball Valves

J. Lawrence Anning has been named sales engineer for Rockwood Ball Valves & Steel Pipe Union Division, and has taken over the West territory with headquarters in Houston. He succeeds Henry Sullivan in this area, Sullivan having been transferred to the Midwestern territory, Chicago headquarters.

Anning

Anning previously had been with Republic Supply Company, having served first as sales engineer and then chief engineer, engaged in warehousing, new store construction and technical sales problems. Since September, 1950, he has been entirely on refinery and industrial sales.

After leaving Illinois Institute of Technology in 1919, Anning served with Deepwater Oil Refineries for eight years. Before joining Republic in 1946, he worked as manager of a steel fabricating plant in Houston and later as engineer, chief inspector, plant engineer and refineries manager of a butadiene plant and a 100-octane plant.

Atlantic Promotes Hersberger

Dr. Arthur B. Hersberger, formerly manager of the Chemical Products Section, has been appointed manager of The

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AIR COOLED HEAT EXCHANGER
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Atlantic Refining Company Product Sales Division. John Martin Hoerner, sales supervisor in the Chemical Products Section, has been named to succeed Dr. Hersberger in his former capacity.

Cromwell Heads Commercial Division Sales for De Laval

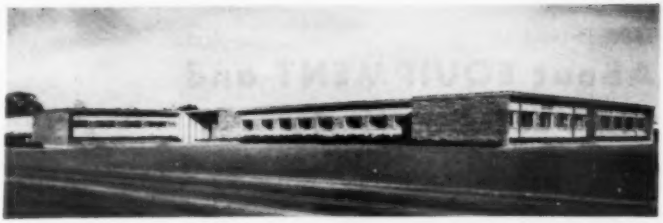
C. E. Cromwell has been appointed sales manager of the Commercial Division of the De Laval Steam Turbine Company which is located in Trenton, N. J. Associated with the company since 1939, Cromwell served 10 years as a sales engineer and for five years as district manager of the company's Detroit office. During the war he served in the Corps of Engineers from 1942-46.

Cromwell

A graduate of the Rose Polytechnic Institute, he majored in mechanical engineering.

Davison Chemical Division Adds Dr. Whitney to Research Unit

Dr. Ambrose G. Whitney, formerly with Armour & Company in Chicago, has joined The Davison Chemical Corporation's Research and Development Department as a development engineer. A graduate in chemistry from the College of St. Thomas, St. Paul, Minn., in 1936, he received his Ph.D. degree from the University of Minnesota in 1940.



INTEGRATED HOUSTON QUARTERS have been built by The Lummus Company, designing engineers and constructors for the petroleum and chemical industries, who have been active in designing and building many plants and buildings in the Gulf and Southwest area. Located on the outer reaches of Houston, the large Houston headquarters houses a heavy concentration of design, engineering and construction functions in addition to various service departments. Main offices of The Lummus Company are in New York City.

Wichita Chemical Plant Opened To Supply Mid Continent Area

Full-scale production of caustic soda, muriatic acid and chlorine is under way at the Frontier Chemical Company plant at Wichita, Kans. The plant will provide these chemicals to the Mid-Continent area. Frontier has been supplying chemicals to the Southwest, and more recently to the Rocky Mountain area from production at Denver and Denver City, the latter in Texas. Home offices for the company were recently moved from Midland, Texas, to Wichita.

Nalcat Opens N. Y. Offices

Sales offices for the Catalyst Division of the National Aluminate Corporation were opened at 141 East 44th Street, New York early this month, when Gage Averill, sales manager of the Division, moved his headquarters from Chicago to New York to serve the growing Eastern market for Nalcat catalyst.

Chemical Consulting Services Office Is Opened in Chicago

Harold E. Bode and Charles D. Lowry, Jr., have organized the firm of Bode-Lowry & Associates, 80 East Jackson Boulevard, Chicago, to act as consultants in market research and sales development in the chemical field.

Bode was employed for 20 years as head of chemical market research and assistant director of chemical patents for the Corn Products Refining Company. He holds the degree of Chemical Engineer from Armour Institute, now the Illinois Institute of Technology, and for the past six years has been

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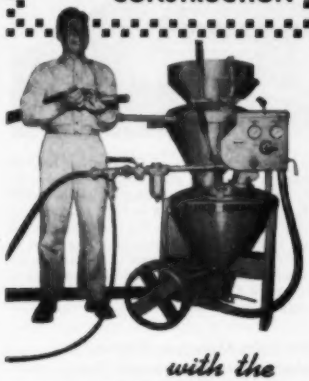

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in the market research field as head of the Belmont Chemical Sales Development Company. This company will continue as a sales agency.

Until recently Dr. Lowry was engaged in technical sales of antioxidants for petroleum and food products for the Universal Oil Products Company. He studied organic chemical research at Northwestern and Harvard Universities and the University of Munich. He holds a number of patents and has contributed many articles to the chemical literature on petroleum technology and the use of antioxidants.

Peerless Pump Appoints Brisbois New Process Pump Specialist

Roy F. Brisbois has been named process pump specialist with headquarters in Los Angeles, by the Peerless Pump Division of the Food Machinery and Chemical Corporation. He will devote his time to pump application problems in refineries, chemical process and industrial plants. A 1941 graduate of the University of Southern California in mechanical engineering, he served four years as an engineering officer in the Merchant Marine. The past five years he has been active in sales work for the Peerless Pump Division in the Pacific Coast area.

Brisbois

Cooper-Bessemer Expands New York Sales Engineering

The Cooper-Bessemer Corporation, engine and compressor builders, recently expanded its sales engineering facilities by the appointment of Roy W. P. Johnson to its New York office. Johnson, who recently completed a training course on engine and motor-driven compressors at the Cooper-Bessemer factory in Mount Vernon, Ohio, is an engineering graduate of Kingston-on-the-Thames Technical College, England, and spent two years in the Research and Design Departments of the Electrical Musical Industries, Middlesex, England. Prior to joining The Cooper-Bessemer Corporation he served the Andian National Corporation in Colombia as a mechanical engineer supervising construction.

Johnson

Nielsen Named to Executive Capacity With Babcock & Wilcox

Recently elected an assistant vice president of The Babcock & Wilcox Company, M. Nielsen will work directly with C. H. Gay, vice president of manufacturing. Nielsen, whose headquarters are in Barberton, Ohio, joined the company in 1924 and by progressive promotion was named superintendent of production

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See page 252 in the Refinery Catalog.

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CHANGING ITS NAME on its fiftieth anniversary, Chicago Metal Hose Corporation became Flexonics Corporation this month to reflect the spectacular growth of the company and the development of varied product lines. The new corporate name is more representative of the broad scope of company activities, according to President J. F. P. Farrar. Established in 1902, the company pioneered development of flexible metal hose and tubing for industrial uses. Flexonics Corporation now manufactures more than 150 products and is now building its sixth manufacturing plant in Memphis, Tenn., to be used to expand production of aircraft assemblies, urgently needed for the defense program. The other plants are located in Maywood, Elgin, Rock Falls, and Savanna, Illinois; an Eastern Assembly Warehouse in Elizabeth, N. J., and a Canadian subsidiary at Brampton, Ontario. The general offices of the company are at Maywood, Ill.

at Barberton in 1947. Since 1950 he has served as executive assistant with headquarters in New York. He is a member of the ASME, and various naval engineering organizations.

Barnett Elected Sales Executive Of A. P. Green Fire Brick Firm

The A. P. Green Fire Brick Company of Mexico, Mo., has appointed A. R. Barnett vice president in charge of sales. Barnett, a company employe for 28 years and general sales manager for the past 21 months, attended the University of Illinois and taught at the Gem City Business College in Quincy, Ill., prior to joining the A. P. Green organization. Barnett has also served in the sales, manufacturing, shipping and finance divisions of the firm.

Barnett

Insul-Mastic Annual Sales Forum Features Engineering Experts

The annual sales and technical forum for the licensees of the Insul-Mastic Corporation of America, held in New Orleans, featured speakers holding important engineering positions as well as group discussions led by experienced licensees. Elmer R. Queer, Pennsylvania State College; W. H. Zane, Du Pont insulation engineer; Herbert L. Coe, United States Steel Company, and Frank R. Jelinek, Neches-Butane Products Company, were the principal speakers.

G-E Names Travis Manager of New Apparatus Sales Division

S. Vernon Travis, Schenectady, has been appointed manager of the newly-established sales standards section of General Electric Company's Apparatus Sales Division. Previously, Travis was assistant general sales manager of the company's former Large Apparatus Division.

He graduated from Union College in 1911 with a B.S. degree in electrical engineering, and joined G. E. the same year as a student engineer.

New Sales Managers Named as Lukenheimer Reorganizes Setup

Reorganization of sales territories and executive appointments has been announced by The Lukenheimer Company of Cincinnati, manufacturer of valves and engineering devices. Newly created divisions are: Eastern under direction of Melvin W. Pauly, sales manager; Central under Harold H. Layritz, and Western under Charles W. Burrage.

Pauly

Layritz

Burrage

R. J. Sardieck, with headquarters in Philadelphia, has been appointed district manager for the Eastern Division. E. R. Tieberman fills a like position for the Central Division with headquarters in Dallas; C. B. Rosser, Jr., has been named to the Los Angeles office for the Western Division.

J. W. Greer Company Promotes Three; Opens New Pacific Office

The J. W. Greer Company, Cambridge, Mass., has opened a new office in San Francisco under the direction of Charles R. Becker, former sales manager at Cambridge. This office will concentrate on 13 western states, Mexico and Western Canada.

Walter Salter, Southeastern representative for the Greer Company, has been transferred to New York offices to head eastern and southern services. He succeeds Melvyn Mickevic. In addition, Rod Grace, who has been the representa-

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tive in New England and Canada, has been named to the vacancy in the Cambridge sales office.

Brewer Heads Pacific Sales For United Centrifugal Pumps

Dahl E. Brewer of United Centrifugal Pumps has been placed in charge of sales throughout Northern California and Utah. He has served in various capacities for the Oakland, Calif., plant over a period of several years, and has spent 15 years engaged in the engineering and sales of centrifugal pumps in petroleum and industrial fields.

Brewer

United Centrifugal Pumps was established in 1886 and has specialized in the design and manufacture of centrifugal pumps for the past 30 years.

John B. Astell Officers Named

New officers were named recently to head John B. Astell & Company, New York warehouse distributors of boiler tubes, pipe, tubing and fittings. Elected were: chairman of the board, John B. Astell; president, H. L. Bialock; vice president, Frank J. Heinzmann; secretary, Edward J. Mogol.

Bialock formerly was manager of sales for the tubing specialties division of the National Tube Company.

FORMAL PLANT OPENING at Dallas of the American Meter Company's new plant was preceded by the annual sales meeting attended by representatives of the sales department and key members of the company's manufacturing divisions. The new plant will produce Orifice Meters and related equipment. Donald Holtz, insert, is manager of the plant; other members of the company grouped in the plant reception room are, left to right: Wm. B. Ashby, secretary; T. A. Bracken, Jr., treasurer; A. F. Benson, vice president–engineering; C. B. Dushane, Jr., vice president–sales; W. G. Hamilton, Jr., president; A. McBeath, controller; A. E. Weingard, vice president–production; D. C. Struble, vice president–purchasing, and D. C. Wiley, vice president–research.

Aquatrol Services Extended For Complete Oil-Gas Coverage

Aquatrol, Inc., a major water treating company, has extended its facilities for complete service to the oil, gas and related industries located west of the Mississippi. With home office, plant and laboratory located in Houston, the company manufactures and markets internal water treatment for industrial applications. Services in the West Coast area are headed by J. M. Adams, who is located at Anaheim, Calif.; the Mid Continent and Texas Panhandle area by W. L. Latham at Oklahoma City; the lower Gulf Coast and West Texas area by R. O. Johnston; the upper Gulf Coast areas by George M. Keith at Houston.

Miller, Worthington Pump Compressor Authority, Retires

One of the country's leading compressor authorities, Herman H. Miller, retired recently after spending 50 years with the Worthington Pump and Machinery Corporation. He started his career in 1901 as an application engineer with Laidlaw-Dunn-Gordon which subsequently became the Worthington

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Pump and Machinery Corporation. He later served as manager of the Air Compressor Department, New York, and as sales manager of the Cincinnati plant. In 1932 he was named manager of the Compressor Division when the Cincinnati plant was consolidated with the Buffalo plant. Miller has been a member of the ASME for 25 years.

B&W Tube Organization Officers Absorbed By Parent B&W Company

The recent merger of the Babcock & Wilcox Tube Company with the Babcock & Wilcox Company resulted in reorganization of the executive staff and the inclusion of a Tubular Products Division within the B&W Company. J. H. King, vice president of The Babcock & Wilcox Company has been named to head the reorganized Boiler Division while Luke E. Sawyer and Edward A. Livingstone, president and vice president of the absorbed Tube Company, have been elected vice presidents of the surviving company.

King

Livingstone

Sawyer

The Boiler Division now comprises what was formerly the Marine, Stationary Boiler and Special Products departments. The former Tube Company operations will not be altered, and will continue its former activity at the Beaver Falls, Pa., plant under the direction of Sawyer.

Air Reduction Names John Lund District Manager at Shreveport

John Lund has been appointed district manager of Air Reduction Magnolia Company replacing Heber T. Wadley, who died recently. Lund will make his headquarters at Shreveport, La., with sales responsibility for that district. Formerly assistant to Wadley, Lund is familiar with the company's operations in the Louisiana, Arkansas, and East Texas territories served by the Shreveport office. He has been a member of the Air Reduction staff since 1927 when he joined the technical sales department, and his sales experience includes service at Detroit, Oklahoma City and Shreveport.

Lund

Ethyl Adds Technical Writers To Detroit Information Division

Marshall Sittig, technical writer, and Patricia Lynn Brown, literature researcher, have joined the information dvision of the Ethyl Corporation research laboratories at Detroit. Sittig, formerly with the engineering division of Chrysler Corporation in Detroit, is a native of Oak Pak, Ill., and a graduate of Purdue University with a B.S. degree in chemical engineering.

Miss Brown was formerly a research associate at Albany Medical College. She is a graduate of Southwestern Louisiana Institute with a B.S. degree in chemical engineering and of the University of Texas with an M.A. degree in chemistry.

Airetool Manufacturing Adds British Isles Distributor

Addition of a British representative to its Export Sales Division has been announced by The Airetool Manufacturing Company of Springfield, Ohio. G. B. Herbert of Morden, Surrey, England, will handle distribution of Airetool tube expanders, tube maintenance equipment and tube rollers for use in the chemical, and refinery fields, etc., in the British Isles. Airetool already maintains sales offices in South America, Mexico and Canada.

York Corporation Appoints New Medical Center Health Director

Louis G. Fetterman, M.D., has been appointed medical director of York Corporation to replace Dr. W. H. Schellhammer, recently retired after 20 years service with the company. Dr. Fetterman will continue a long range full time industrial health and medical program which his predecessor inaugurated. The new head of the company's Medical Center was formerly associated with Hershey Estates as industrial physician. Prior to that time he maintained a private practice in Campbelltown, Pa., for many years, and served in the Army Medical Corps during the war.

Refinery Engineering Appoints Glenn Hopkins PR Director

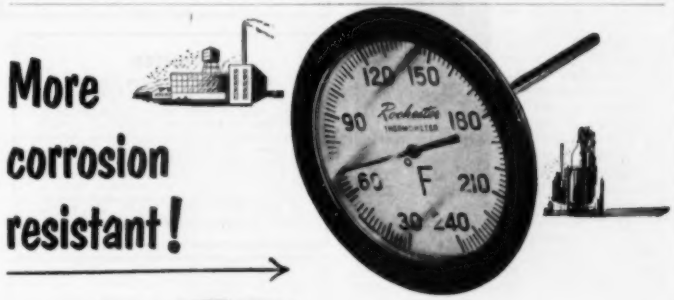
Glenn O. Hopkins, until recently an advance placement manager, advertising manager and Veterans Administration contract officer for the Spartan School of Aeronautics, has been appointed public relations director and advertising manager for Refinery Engineering Company of Tulsa. Hopkins, who taught in the Kansas system of public schools for ten years, holds an education degree from the Kansas State Teachers College at Pittsburgh.

Hopkins

Consolidated Advances Lee

Charles W. Lee has been appointed vice president of production of the Consolidated Western Steel Division of the United States Steel Company, succeeding Lloyd Earl. He will headquarter in Los Angeles.

Lee has been a resident of Houston



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since 1946, serving as operations vice president of Consolidated's Texas operations. He has worked for Consolidated all over the world, mainly in the Philippines and the Orient. During World War II he was vice president of Consolidated Western's ship yards at Wilmington, Calif.

Cooper-Bessemer Appoints New Sales-Engineer to Shreveport

T. M. Lamberth, Jr., mechanical engineering graduate of Texas A. & M. College, has been transferred from The Cooper-Bessemer Corporation manufacturing plant in Mount Vernon, Ohio, to Shreveport, La., as sales and engineering representative. He will work under the direction of A. K. DeFrance, branch manager of the company office and warehouse there.

Lamberth

Prior to joining The Cooper-Bessemer organization, Lamberth was a sales engineer with Joseph A. Coy Company and Arrow Industrial Manufacturing Company, manufacturers of heat transfer equipment.

Walworth Company Names Holton, Eichler in Election Promotion

W. B. Holton, Jr., a director of Walworth Company since 1925 and president since 1936, was recently elected chairman of the board of directors. Alfred J. Eichler will replace Holton as president and chairman of the executive committee.

Eichler

Holton served as production consultant for valves and fittings with the War Production Board during the war. Eichler, vice president in charge of sales for a number of years, previously managed the foreign business for the company and maintained residence in Buenos Aires for four years.

Tube Turns Names Lincoln Hall Mid-Continent District Manager

New district manager in charge of the Mid-Continent territory for Tube Turns, Inc., Louisville, is Lincoln D. Hall, who makes his headquarters in the Wright Building, Tulsa. Hall succeeds Robert S. Tyler, Jr., who resigned.

Hall

Hall holds a degree from Pomona College and also did post-graduate work in engineering at the University of Southern California. His experience includes ten years as manager of stores and production for C. F. Braun

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& Company, and also a period as West Coast sales manager for the Taylor Forge & Pipe Works.

Kinney Promotes Fred James

Fred K. James, formerly associated with the Chicago branch of Kinney Manufacturing Company, has been appointed manager of the company's Cleveland organization. In Chicago James served as a salesman.

De Laval Forms Pacific Company For Distribution of Products

Formation of a subsidiary corporation, the De Laval Turbine Pacific Company, has been announced by the De Laval Steam Turbine Company of Trenton, N. J. Headquarters for the new company will be in San Francisco with operations under direct charge of C. F. Reeves, vice president and general manager. Other officers include G. W. Smith, Jr., chairman; and J. P. Stewart, president. Branch sales offices in Los Angeles and Seattle are under the direction of H. H. Reynolds and J. A. Greenland, respectively. The new company will also act as representatives for Waukesha industrial engines, Kellogg-American air compressors, and Diehl Electric motors and other allied industrial lines.

Reeves

Hauseman Named New Marketing Executive of Davison Chemical

Appointment of David N. Hauseman, retired brigadier general U. S. A., as a marketing executive of The Davison Chemical Corporation has been announced. Hauseman lately retired as president of Houdry Process Corporation, served in the army for 29 years before retiring in 1946. He became executive vice president of Temple University, Philadelphia, in his retirement year, and later was elected to the board of directors and made president of the university's Research Institute. He joined Houdry in 1948 upon the retirement of the president and founder, Eugene J. Houdry.

Hauseman

European Experts Study Equipment During "Operation Impact" Tour

Ten petroleum experts from five free European nations were conducted through Worthington Pump and Machinery Corporation's Buffalo plant recently, as one visit during their six-week tour of American plants. Known as "Operation Impact," the tour is conducted to demonstrate modern American equipment and methods and is sponsored by the Economic Cooperation Administration. Countries represented were England, Italy, The Netherlands, France and Belgium.

Byron Jackson to Buy Indiana Pump Manufacturing Concern

Byron Jackson Company is adding to its organization the A. D. Cook Pump Company located at Lawrenceburg, Ind. The purchase gives the company an additional 150,000 feet of space to be used for manufacturing centrifugal pumps and Cook vertical turbine pumps. It is anticipated that the Cook Company dealer organization will be continued.

Wallace Named to New A-C Post

William M. Wallace has been appointed an assistant to the vice president of Allis-Chalmers Manufacturing Company general machinery division. Since 1947, he has been special assistant to G. V. Woody, manager of the company's processing machinery department. He entered Allis-Chalmers employ in 1937.

Elvin R. Danielson has been named supervisor of priorities succeeding the late Robert T. Ward. Danielson in his new post reports to Wallace.

Du Pont Advances Chemical Men

Four members of Du Pont's Petroleum Chemicals Division were advanced to new posts, effective January 1.

T. Baldwin Prickett was named planning manager; Robert F. Harwick became sales promotion manager; Richard O. Bender was appointed assistant technical manager; and Arthur F. Bowe, formerly manager of the Eastern District Laboratory, at Deepwater Point, N. J., was appointed laboratory coordinator.

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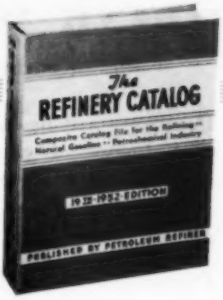

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In seeking copper and brass scrap we cannot appeal to the general public, nor, for that matter, to the small businesses, important though they are, which have only a few hundred pounds or so to dispose of at a time. Scrap in small amounts is taken by dealers, who perform a valuable service in collecting and sorting it, and making it available in large quantities to the mills. Revere, which ships large tonnages of mill products to important manufacturers, seeks from them in return the scrap that is generated, which runs into big figures of segregated or classified scrap, ready to be melted down and processed so that more tons of finished mill products can be provided.

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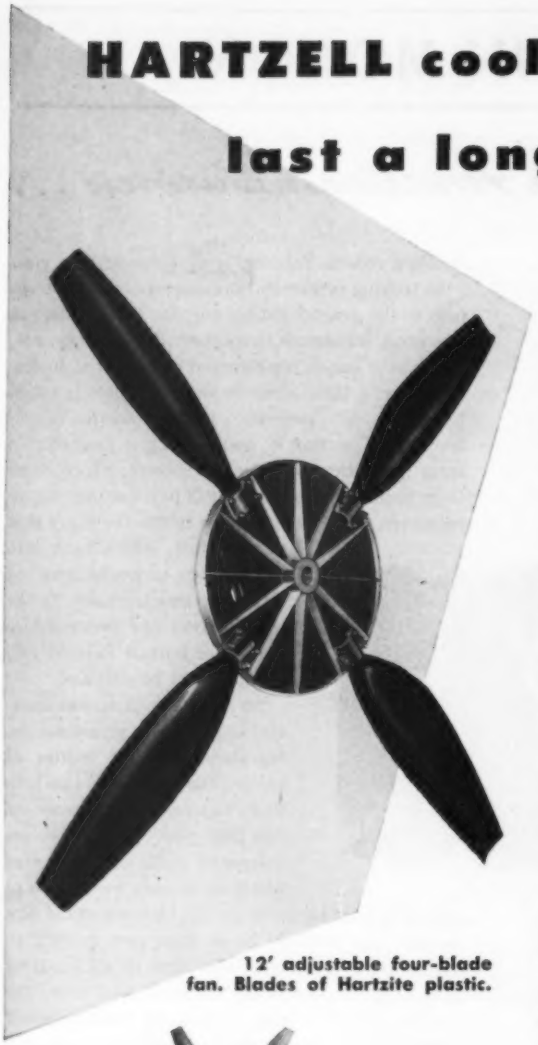

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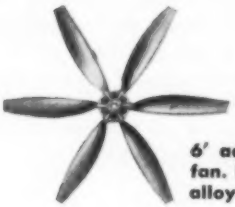

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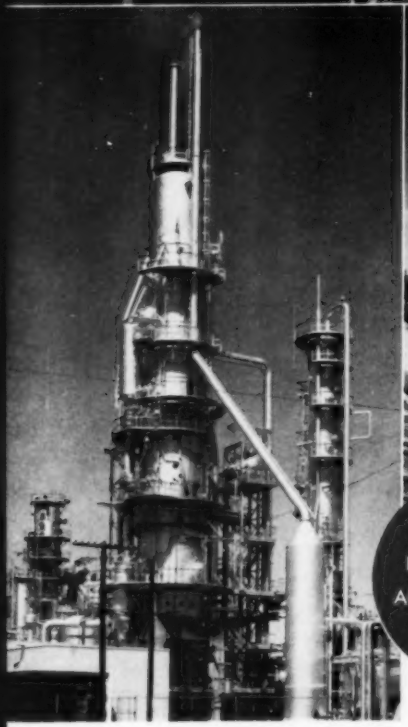

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